THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE V. VOL. I.

No. IV.—APRIL, 1904.

ORIGINAL ARTICLES.

I.—A Retrospect of Palæontology in the last Forty Years.

(*Concluded from the March Number, p.* 106.)

Reptilia et Aves.—Our two greatest Anatomists of the past century, Owen and Huxley, both contributed to this section of our palæozoological record. Owen (in 1865) described some remains of a small air-breathing vertebrate, *Anthrakerpeton crassosteum*, from the Coal-shales of Glamorganshire, corresponding with those described by Dawson from the Coal-measures of Nova Scotia; and in 1870 he noticed some remains of *Plesiosaurus Hoodii* (Owen) from New Zealand, possibly of Triassic age.

Huxley made us acquainted with an armed Dinosaur from the Chalk-marl of Folkestone, allied to *Scelidosaurus* (Liassic), *Hylæosaurus* and *Polacanthus* (Wealden), the teeth and dermal spines of which he described and figured (1867), and in the following year he figured and determined two new genera of Triassic reptilia, *Saurosternon Bainii* and *Pristerodon McKayi*, from the Dicynodont beds of South Africa.

R. Etheridge recorded (in 1866) the discovery by Dr. E. P. Wright and Mr. Brownrig of several new genera of Labyrinthodonts in the Coal-shales of Jarrow Colliery, Kilkenny, Ireland, communicated by Huxley to the Royal Irish Academy, an account of which appeared later on in the Geological Magazine in the same year by Dr. E. P. Wright (p. 165), the genera given being *Urocordylus, Ophiderpeton, Ichthyerpeton, Keraterpeton, Lepterpeton*, and *Anthracosaurus*. Besides these genera there were indications of the existence of several others (not described), making at that time a total of thirteen genera from the Carboniferous formation in general.

In 1872 the distinguished Canadian geologist, Professor Sir Wm. Dawson, gave an account of and figured *Sauropus unguifer*, being the footprints of an *unknown* labyrinthodont reptile from the Carboniferous Sandstone of Nova Scotia; and in 1891 he announced in two

separate papers the discovery of new specimens of *Dendrerpeton acadianum* and *Hylonomus Dawsoni* from the South Joggins Coalfield, Nova Scotia.

Our old friend William Davies gave an account (in 1876) of the exhumation and working out of a large Dinosaurian, named by Owen *Omosaurus armatus*, from the Kimmeridge Clay of Swindon, Wilts. This specimen is preserved in the Natural History Museum, Cromwell Road, and is a good example of the heavy vegetable-feeding land reptiles of the Jurassic period. In 1880 he described the remains of an Upper Miocene Ostrich from the Siwalik Hills, India.

Professor Prestwich (1879) recorded the discovery of a species of *Iguanodon* in the Kimmeridge Clay near Oxford. In the same year E. T. Newton described *Emys lutaria* from the fluviatile deposit at Mundesley on the Norfolk coast; an Iguanodont tooth from the 'Totternhoe Stone' at Hitchin; "British Pleistocene Vertebrata in Britain" (1891); and Dicynodont and other reptiles from the Elgin Sandstone. He noticed the occurrence (1883) of the Red-throated Diver, *Colymbus septentrionalis*, at Mundesley.

W. H. Twelvetrees (1882) figured some Theriodont reptilian teeth from the Permian of Russia; this formation quite lately has yielded a marvellous series of remains to Professor Amalitzky, of Warsaw. Professor A. Liversidge gave (in 1880) an analysis of Moa egg-shell from New Zealand. So long back as 1864 the veteran anatomist, W. K. Parker, made some important remarks on the skeleton of *Archæopteryx*. He pointed out that although this primitive bird had, in the adult state, 21 caudal vertebræ, a recently hatched duckling possesses 22 caudals if we count the fifth post-femoral as the first of the caudal series; so that, after all, this large number of free caudals is only an embryonal character retained in the adult.

The late Professor O. C. Marsh, of Yale College, New Haven, Connecticut, who died in 1899, was for 23 years a contributor to the pages of this journal, and a very constant visitor to this country; indeed, from his return after his student days in 1864 to the end of his life he was a familiar figure in the British Museum and at the meetings of our scientific societies.

In 1876 Marsh contributed a paper on birds with teeth (Odontornithes) from the Cretaceous of Kansas. The most interesting is perhaps the *Hesperornis regalis*, a gigantic diver. The brain was quite small; the maxillary bones, which were stout, had throughout their length a deep inferior groove thickly set with sharp pointed teeth. The vertebræ were like those of recent birds. The sternum was without a keel, and the wings were quite rudimentary. It has, in fact, been described as a swimming ostrich. In *Ichthyornis* the teeth were in distinct sockets, the vertebræ were biconcave; the sternum possessed a keel; and the wings were well developed for powerful flight.

In 1881 Marsh wrote on the structure of the skeleton in the *Archæopteryx*, and pointed out the many interesting features in which this earliest known bird approaches to the reptilian type and

especially to the Dinosauria. In 1882 he proposed a classification of the Dinosauria which (with some modifications) is still followed by palæozoologists.

In the same year this author discussed the wings of Pterodactyls, basing his remarks on the specimen discovered at Eichstädt, Bavaria, in 1873. This long-tailed form, named *Rhamphorhynchus phyllurus* by Marsh, has both the wing membranes preserved, and shows that the long stiff tail had a broadly expanded extremity like the blade of a paddle, which was evidently used as a rudder. We have a similar form named *Dimorphodon*, which was obtained from the Lias of Lyme Regis (see 1870, p. 97, Pl. IV). In 1884 Marsh figured and described the skull of the great *toothless* American Pterodactyl from the Chalk of Kansas (named *Pteranodon*), with a skull a yard in length, and wings having an expanse of about 18 feet across!—as large as our great toothed *Pterodactylus Cuvieri* and *P. giganteus* from the English Chalk of Burham, Kent.

He also (1884) named *Diplodocus longus*, a new Jurassic Dinosaur, from Cañon City, Colorado, giving figures of the skull, teeth, etc. It possessed one of the most remarkable heads of this singular group of land reptiles and the weakest possible dentition, the teeth being entirely confined to the front of the jaws and of simple slender peg-like form, and they must have been easily detached from their shallow sockets. The nasal opening was at the apex of the cranium, and the brain was of the very smallest dimensions possible.

Then followed an account, with figures, of various other new forms of Jurassic Dinosaurs—*Allosaurus, Cœlurus, Labrosaurus,* and *Ceratosaurus*. These were all carnivorous forms (Theropoda), the last-named being near to our own *Megalosaurus*, the teeth and claws both displaying their predaceous character. *Allosaurus* had extremely diminutive fore-limbs and long slender hind ones, adapted evidently for springing upon its quarry.

Passing from these lithe and active beasts of prey, we come (in 1888) to one of quite another character, namely, Marsh's *Stegosaurus*, a huge plated lizard of the Jurassic period. It had the smallest brain of any known land vertebrate. All its bones were solid, the vertebræ biconcave. Its body was defended by a row of twelve flattened dorsal bony plates, the largest being nearly four feet in height and of equal length; with four pairs of sharply pointed spines fixed erect like bayonets on the caudal vertebræ. A restoration was given by Marsh of this huge herbivore in 1891.

A further comparison of the principal forms of Dinosauria of Europe and America was given by Marsh in 1889, in which he defined the group SAUROPODA or lizard-footed forms. Many of these are known in Europe as well as America, but here they are more fragmentary. A large part of one has just been set up from the Oxfordian of Peterborough, whilst limb-bones of *Cetiosaurus* (as large as those of *Atlantosaurus*) may be seen in the Oxford Museum and in the British Museum (Natural History), London. The section STEGOSAURIA is represented by *Omosaurus*, from Swindon; *Hylæo-*

saurus, Wealden; *Polacanthus*, *Acanthopholis*, and *Scelidosaurus* (all British forms) belong to the armoured Dinosaurs.

The section of the great bird-footed ORNITHOPODA is well represented by *Iguanodon* and its allies in this country and in Belgium, while that of the THEROPODA was known here by *Megalosaurus* since the days of Buckland (1824).

In 1890–91 Marsh brought before the public his gigantic CERATOPSIDÆ, horned Dinosaurs, with skulls of marvellous form, nearly 6 feet from the tip of the pointed snout to the edge of the huge bony frill which expanded between 3 and 4 feet in breadth, like an immense Elizabethan collar, over the creature's neck behind. The skull had three horns, two over the orbits and one on the nasal bone (hence the generic name *Triceratops*); the jaws had sharp horny beaks in front and *two-fanged* molar cheek teeth. It had besides a covering of dermal armour.

An interesting investigation as to the makers of the footprints, so long attributed to *Dinornis*-like birds, met with upon the slabs of fine-grained sandstone in the Connecticut valley, resulted in the discovery by Marsh of a small light-footed Dinosaur named *Anchisaurus colurus*, a little over 4 feet in height, which, although not tridactyle, only impressed three of its four toes on the wet sands in running, touching the tip of the nail only of the fourth toe on the ground. The restoration of this early Dinosaur in 1893 is accompanied by two others, a large carnivorous form like our *Megalosaurus*, the *Ceratosaurus*, and a bird-footed and beaked form, *Claosaurus*, near to our *Iguanodon*, with which it also agrees in size.

A restoration of *Camptosaurus dispar* from the Upper Jurassic of Wyoming appeared in 1894, also footprints of Coal-measure Labyrinthodonts from Kansas. Other restorations of European genera were continued to be published in 1896. First and smallest of all these is the *Compsognathus longipes*, Wagner, preserved on a slab of Lithographic Stone from Bavaria. Next follows *Scelidosaurus Harrisoni* (Owen) from the Lias of Charmouth. Then another very small Dinosaur named *Hypsilophodon Foxii* (Huxley) from the Wealden of the Isle of Wight, and *Iguanodon Bernissartensis* from Belgium.

These were followed by a final classification of the Dinosaurs, with twelve beautifully executed figures, and a note on the Sauropoda which appeared in 1899. Marsh gave the results in 1898 of his visit to St. Petersburg, Moscow, Vienna, Munich, Paris, Caen, Havre, and London, and additional notes on Dinosaurian remains seen during his tour.

Professor H. G. Seeley wrote in 1881 on the Ornithosaurians of the Cambridge Greensand; in 1895 on *Pareiasaurus Baini* from the Karoo formation (Trias) of Cape Colony, obtained by him in 1889 at Bad, near Tamboer-Fontein; the most perfect Anomodont reptilian skeleton then known, only equalled by the specimens recently discovered by Professor Amalitzky in the Trias of Russia. In 1898 Seeley described two Rhætic Dinosaurs, *Avalonia Sanfordi* and *Picrodon Herveyi*, from Wedmore Hill, Somerset; and in the

same year the skull of a Triassic Anomodont (*Oudenodon pithecops*), a small toothless reptile obtained by Mr. McKay, of East London, from the Dicynodont Beds of Cape Colony. In 1881 Seeley gave an account and figure of the Berlin *Archæopteryx*, and discussed the affinities of this second example of long-tailed Oolitic bird when compared with the original example in the British Museum (Natural History), obtained in 1861.

Henry Woodward described and figured *Iguanodon Mantelli* in 1885, and *Iguanodon Bernissartensis* in 1895; he gave in 1885 an account of "Wingless Birds," recent and fossil, with their characters, species, and distribution, both geographically and geologically.

Arthur Smith Woodward gave, in 1885, an excellent summary of the literature and nomenclature of British fossil Crocodilia, with a table of genera and species. In 1891 he noticed a tooth of an extinct Alligator from the Danian of Ciply, Belgium; a Microsaurian (*Hylonomus Wildi*) from the Burnley Coalfield, Lancashire; and noted the occurrence of *Pseudotrionyx* from the Bracklesham Beds. In 1897 he figured and described *Stereosternum tumidum*, a small lizard-like Triassic reptile from San Paulo, Brazil, related in some undetermined way to the ancestry of the Plesiosauria; and a new specimen of *Ceraterpeton Galvani* from the Coal-measures, Kilkenny, Ireland.

In 1887 G. A. Boulenger wrote, with R. Lydekker, some notes on Chelonia from the Purbeck Beds and London Clay.

R. Lydekker, in the same year, wrote on Crocodilians from Hordwell and other species from the Wealden, etc. He also published a note on *Hylæochampsa*. In 1888 he published notes on Tertiary Lacertilia and Ophidia, and discussed their affinities; he also wrote on the classification of the Ichthyopterygia; quoting from the late Sir William Flower in favour of the restriction of generic terms, and urging that their multiplication tends to make us lose sight of the mutual relationship of allied forms, a view in which the author then fully agreed, but subsequently he appeared rather to favour the creation of new species, not merely in extinct, but in recent forms of life. If a *small fee* for registration had to be paid for every new name proposed to be introduced into currency, and a *large one* imposed on the alteration of old and well-established names, in order to replace them by some lost or unknown name unearthed from the dusthole of the past, zoology would be greatly the gainer, and much time might be saved with advantage and devoted to really useful scientific work. Lydekker gave some interesting notes on Sauropterygia from the Oxford and Kimmeridge Clay, from the Leeds Collection at Eyebury. He does some useful 'lumping' of species established upon insufficient data, and mentions a delightful case in which a newly described *Plesiosaurus* presented some very striking peculiarities in its skeleton, arising from the simple mistake made by the author, who had placed the head on the extremity of the tail—the so-called cervicals being indistinguishable from the caudals of other forms. R. Lydekker, in 1889, recorded some remains of a new Cœluroid Dinosaur from the Wealden of the Isle of Wight, which he named *Calamospondylus Foxi*.

Boulenger and Lydekker called attention to a curious case of "the *un*scientific use of the imagination," in which the Abbé G. Smets, in Belgium, figured and described some remains of a new Dinosaur, which, upon examination, proved to be merely a mass of fossil wood.

Lydekker figured and described part of a left pectoral paddle of *Ichthyosaurus intermedius* from the Lower Lias of Barrow-on-Soar, in which the integument is preserved, as in a paddle figured and described by Owen in 1841. In 1891 the same author delineated and noticed a most perfect skeleton of *Ichthyosaurus tenuirostris*, obtained by Alfred Gillett from the Lower Lias of Street, Somerset, and presented by him to the British Museum (Natural History), where it still holds a premier place among its fellows.

Dr. C. W. Andrews, in 1885, gave a note on the skull of *Keraterpeton Galvani*, Huxley, a small Labyrinthodont from the Coal-measures of Staffordshire, originally described by Huxley from the Kilkenny Colliery, Ireland. In the same year he described the skeleton of a young Plesiosaur from the Oxford Clay of Peterborough, and in 1896 the pelvis of a large Plesiosaur (*Cryptoclidus oxoniensis*), also forming part of the Leeds Collection.

In 1895 Andrews discussed the *Stereornithes*, a group of extinct birds from Patagonia, and made some interesting remarks on the recurrence of flightless or wingless birds in groups, as those of South America and of New Zealand, and the Gastornithidæ in the Eocene of Europe. He contended that there seemed no reason why such groups of flightless birds should not arise at any period and in any region, providing the conditions of life were favourable. In 1896 he noticed the nearly complete skeleton of *Aptornis defossor*, a gigantic flightless rail from New Zealand, of which an excellent figure was given, followed later by an account of *Diaphorapteryx Hawkinsi*, Forbes, a large extinct rail from the Chatham Islands, 500 miles east of New Zealand. All these flightless birds shared the same fate as the Dodo and *Dinornis*, having been eaten up by man.

Another interesting insular flightless bird was described by Andrews in 1897, the *Æpyornis Hildebrandti* from Madagascar, a restored skeleton of which was set up in the British Museum (Natural History), from remains obtained by Dr. C. I. Forsyth Major at Sirabé, Central Madagascar.

Lastly, in 1899 he figured the nearly complete skeleton of *Dinornis maximus*, obtained by C. A. Ewen near Invercargill (South Island), New Zealand, one of the most genuine specimens obtained; those sent home by the late Sir Julius von Haast having been mostly composite skeletons, not belonging to one bird.

Professor Seeley gave in 1887 some interesting notes on Louis Dollo's work on the Dinosauria of Bernissart, especially in reference to the *Iguanodon Bernissartensis* and the relation of Dinosaurs to Birds. Mr. Dollo also contributed an article on some Belgian fossil reptiles, with special reference to *Hylæochampsa* and *Bernissartia*. In 1888 the same author wrote on the humerus of *Euclastes*, and discussed the relationship of the Propleuridæ with the Cheloniæ.

In 1899 Dr. G. Baur reviewed E. T. Newton's memoir on the skull of *Scaphognathus*.

The egg of a large Struthious bird (*Struthiolithus chersonensis*) found in a Post-Tertiary deposit at Kalgan, North China, was described and figured in 1898 by C. E. Eastman, of Cambridge, Massachusetts, United States. As no bones of any ostrich-like bird have been met with in China, we must receive the evidence of the egg alone with some reserve, although the account is very well authenticated.

In 1900 Eastman described a fossil bird (*Gallinuloides Wyomingensis*) from the Middle Eocene, Wyoming, with short beak, stout legs, and about the size of a gallinule, rail, or small coot, and resembling those birds in general characters.

In 1903 Professor R. Broom figured the palate of *Scylacosaurus Sclateri*, a new primitive Theriodont from South Africa, and a new Stegocephalian reptile from Ariwal North, Cape Colony.

In 1900 Professor Burckhardt gave a description and excellent figures of *Hyperodapedon Gordoni* from the Trias of Elgin; and G. A. Boulenger, in 1903, described the palate of *Hyperodapedon* and of a new genus, *Stenometopon*, also from the same deposit.

Baron Francis Nopcsa, jun., had an article in 1903 on the origin of the Mosasaurs, and discussed the question as to whether Mosasaurs were highly specialized aquatic Varanoids, or sprang from the Neocomian Dolichosaurs, or were an offshoot from some ancient Lacertilia.

Mammalia.—Professor Owen, who was among our earliest contributors, wrote in 1865 on *Miolophus*, a new genus of Eocene mammals. A year later the specimen so described by Owen proved to be the type of *Platychærops Richardsoni* (Charlesworth), (Brit. Assoc. Rep., 1854, p. 80), from the London Clay, Herne Bay (see Geol. Mag., 1866, p. 48), and was claimed for the York Museum, to which it belonged. In 1866 Owen described the lower jaw and teeth of a small Oolitic mammal from the Purbeck beds of Dorset, which he named *Stylodon pusillus*, probably a small Insectivore. He next wrote in 1869 on *Castor* and *Trogontherium*, and gave figures of the limb-bones and teeth of the gigantic beaver of the Norfolk Forest Bed series. This great beaver occurred also in the Thames Valley (see Geol. Mag., 1902, p. 385); in the Department l'Eure et Loire in France; at Taganrog, on the Sea of Azof; and near Odessa, on the Black Sea. In the same year he recorded the occurrence of the Elk (*Alces palmatus*) from the North Tyne River, Northumberland, and from the East London Waterworks at Walthamstow, Essex. A. Smith Woodward, in his "British Fossil Vertebrates" (1890), gave no fewer than thirty-two localities, to which may now be added Keiss, Caithness, and Cleveland, Yorkshire. In 1883 Owen figured and described a newly discovered skull of *Thylacoleo* from Queensland, Australia, a palatal view of which is given.

In 1865 Harry Seeley described the cervical vertebræ of a whale, *Palæocetus Sedgwickii*, from the Boulder-clay of Ely, in the Woodwardian Museum.

In the same year Dr. A. Leith Adams gave an account of the first discovery, in 1857, by Dr. S. Agius, of the bones and teeth of fossil elephants, associated with the great dormouse, *Myoxus melitensis*, in the Gandia Fissure, Malta. But the best-preserved remains of the pigmy elephant were obtained by Captain Spratt, R.N., from the Zebbug Cave in 1859.

In 1867 Professor Sir Frederick McCoy noticed the occurrence of *Squalodon Wilkinsoni*, from the Miocene Tertiary of Victoria, Australia, a primitive whale with teeth provided with bicuspid fangs. Teeth of this whale have also been found in the Red Crag of Suffolk, in Malta, France, and North America.

Henry Woodward, in 1864, described the discovery and exhumation of a skull and tusks of *Elephas primigenius* from the Brick-earth at Ilford in Essex, and in 1868 figured the skull and tusks in order to show that their normal curvature in the aged Mammoth was *inwards* at their extremities, not outwards, as had hitherto been depicted by Waterhouse, Hawkins, and others. In 1869, under the title of "Man and the Mammoth," the same writer gave an account of the animals found associated with early man in Britain during prehistoric times, in which a table was also given of the species which are extinct or have been killed, have migrated or are still living in this country. An article in the same year recorded the animals found in the fresh-water deposits of the Valley of the Lea near Walthamstow, Essex.

In 1871 Henry Woodward described the Mammoth skeleton from Lierre, Belgium, set up in the Royal Museum of Natural History at Brussels, and gave a brief account of the other objects of interest in that collection. In 1874 the same writer gave an account of the very perfect skull of *Rhinoceros leptorhinus*, from the Pleistocene Brick-earth of the Valley of the Thames at Ilford. The author pointed out that Falconer's name of *R. hæmitechus* must give place to Owen's *R. leptorhinus*, inasmuch as the species had a completely ossified nasal septum. In 1885 he recorded the addition to the British Museum of a nearly complete skeleton of Steller's sea-cow, *Rhytina gigas*, from Behring Island, and a restored skeleton of *Halitherium Schinzi*, from the Miocene of Hessen Darmstadt, and he pointed out that at present the living Sirenia were all confined within a band 30° north and 30° south of the equator, but in late Tertiary times they extended to 60° north, about 28 species being met with in North America, England, France, Belgium, Holland, Italy, Germany, and North Africa; affording additional evidence, if such were required, of the former northern extension of warmer conditions of climate in Europe in the near past.

In 1886 H. Woodward gave an account of recent and fossil *Hippopotami*. In 1898 he described the great red-deer antlers from Bakewell, Derbyshire; a year later he figured the skull and tusks of the famous *Elephas ganesa*, which forms so striking an object in the centre of the Geological Gallery of the British Museum (Natural History). In 1903 he noticed some recent cave-hunting in Cyprus by Miss Dorothy M. A. Bate.

W. Boyd Dawkins discussed, in 1868, the value of the evidence for the existence of the Mammoth in Europe in pre-Glacial times, and he concluded that the evidence forthcoming did not, in his opinion, support the contention of the pre-Glacial age of the Mammoth, which must be considered to be of later date.

In 1870 Professor Huxley contributed a paper on the milk-dentition of *Palæotherium magnum*, in which he pointed out that the genus *Paloplotherium* was founded upon a mistake, and it disappears from zoological nomenclature. Professor James Geikie described the occurrence in 1868 of *Bos primigenius* in the Lower Boulder-clay of Scotland.

E. Ray Lankester announced (1869) the discovery of a new Trilophodont *Mastodon* in the Suffolk Bone-bed at Woodbridge, and in the same year the finding of a portion of the tusk of the great sabre-toothed tiger *Machairodus* from the Forest-bed at Cromer, on the Norfolk coast. In 1899 he returned to the subject of the Trilophodont *Mastodon* from the Suffolk Crag, and refigured his *Mastodon angustidens* as var. *latidens*, the obscuring phosphatic matrix having been removed.

Professor Robert Harkness (1870) mentioned the occurrence of elephant-remains in Ireland. He concluded that there is good evidence of the Mammoth having been met with in Shandon Cave, Dungarvan, co. Waterford.

In 1871 Dr. James Murie gave figures of the skeleton and an admirable restoration of *Sivatherium giganteum*, a type of Miocene Tertiary short-necked horned ruminants, which with *Helladotherium*, *Bramatherium*, *Samotherium*, and some others belong to the Giraffidæ, and of which the long-necked giraffe and the recently discovered short-necked Okape alone survive.

William Davies (1878) recorded the animals obtained by J. J. Owles, of Yarmouth, from the Dogger Bank in the North Sea, an old Pleistocene or Post-Glacial land lying off the east coast and once a part of these Islands when they were joined to the Continent, and the bear, wolf, hyæna, the Irish deer, the reindeer, red deer, urus, bison, horse, rhinoceros, mammoth, beaver, elk, musk-ox, etc., were common British animals. He noticed a fine jaw of mammoth dredged from the Dogger Bank in 1837, and in 1879 mentioned the occurrence of the musk-ox (*Ovibos moschatus*) from the Thames Brickearth at Crayford in Kent. In 1880 Davies announced the discovery (by James Backhouse, of York) of the northern lynx (*Felis borealis*) in a cave in Teesdale, Durham. He added a new British carnivore in 1884, the civet (*Viverra Hastingsiæ*), from the Eocene of Hordwell, Hampshire.

In 1880 E. T. Newton commenced a series of papers on the Vertebrata of the Pre-Glacial Forest Bed series of the East of England. In his first paper he recorded the wolf, fox, *Machairodus*, *Felis*, marten, glutton, bear (two species), walrus, and a seal. In his second paper he gave the horse, the ass, four species of *Rhinoceros*, *Hippopotamus*, two species of pig, ox, bison, sheep, goat, thirteen species of deer, and the reindeer (*Rangifer tarandus*). In 1882

he noticed the occurrence of the marmot, *Spermophilus*, beneath the Glacial Till of Norfolk. In 1883 he described the teeth of *Hyæna crocuta*, var. *spelæa*, from the Forest Bed at Corton, Suffolk. In 1887 he figured remains of the otter, the eagle, owl, shoveller duck, and cormorant, all from the Forest Bed series. E. T. Newton added, in 1889, descriptions of *Cervus rectus*, *Bison bonasus*, *Phoca barbata*, *Delphinapterus leucus*, and *Phocæna communis*. In 1890 the same author noticed the occurrence of Lemmings and other rodents in the Brickearth of the Thames Valley, Crayford. Lastly, in 1902, he recorded the discovery of *Trogontherium*, the giant beaver, from near Greenhithe, Kent, in the valley of the Thames.

Sir Henry Howorth wrote in 1880 on the Mammoth in Siberia, giving a number of interesting facts to prove the very early date in history when, by the trade-routes, Mammoth ivory was brought south-west into Europe from Siberia. In 1901 he wrote of "the earliest traces of Man," taking as his text the evidence of Palæolithic Man in Africa, by Sir John Evans, H. O. Forbes on the stone implements from Egypt and Somaliland, Ashington Bullen on Eolithic implements, etc.

Richard Lydekker had a series of three papers on the Artiodactyla, etc., in 1885, and on the teeth of *Hyænodon* in 1890.

Professor O. C. Marsh (in 1887) wrote on American Jurassic mammals, and figured and described many forms closely resembling our Purbeck and Jurassic microtheres, of which he made us acquainted with no fewer than 26 species. In 1889 he illustrated the skeleton of the great *Brontops* (*Titanotherium*), a huge *bony*-horned *Rhinoceros* with two blunt *bony* prominences on its snout near the extremity, placed side by side. He figured *Coryphodon hamatus* in 1893, a huge Amblypodous ungulate allied to *Dinoceras*, from the Lower Eocene of Wyoming, U.S.A. In 1894 he gave a restoration of *Elotherium crassum*, a pig-like animal from the Miocene of North-Eastern Colorado, only surpassed in bulk by the Rhinoceroses and Titanotheres, its contemporaries. In 1899 Marsh published his Address on the Origin of Mammals (delivered at Cambridge August 25th, 1898). On the 18th March he passed away in his 68th year, having done a day's work and done it well.

Dr. C. I. Forsyth Major wrote in 1890 on the Pliocene Mammalian Fauna at Olivola in the Carrara Mountains, and recorded *Felis*, *Machairodus*, *Hyæna robusta*, *Canis*, *Ursus etruscus*, *Rhinoceros etruscus*, *Equus stenonis*, *Mastodon arvernensis*, *Sus Strozzi*, *Cervus dicranius*, *Leptobos elatus*, *Castor*, etc. In 1899 he described *Sciurus Bredai* and *S.* sp., *Lagopsis verus*, and *Cricetodon minus*, from the Middle Miocene of Oeningen; fossil dormice, *Muscardinus sansaniensis*, and *Eliomys Hamadryas*, from Sansan and La Grive Saint-Alban, and on *Pliohyrax græcus* from the Upper Miocene of Samos and Pikermi.

In 1900 Forsyth Major gave a summary of what was known of the extinct primates of Madagascar—*Megaladapis*, *Palæochirogalus*, *Nesopithecus*, and *Hadropithecus*; and in 1901 an interesting article on the transference of secondary sexual characters of mammals from

males to females, the horns of the Giraffidæ, the antlers of the deer tribe, and the horns in the Bovinæ and Capridæ being considered, the reindeer and roedeer and sometimes the red-deer having antlered females, and the tusks also in the Suidæ (in the *Potamochœri*) being almost equal in size and shape to those of the males. Also he wrote on a supposed camel and a nilghai (*nylghau*) from Samos; the former proved to be a hornless skull of the female *Palæotragus Rouenii*, a small Giraffoid form, and the nilghai to be another of the Giraffidæ, *Palæotragus vetustus*.

During his visit to Madagascar, in 1895, Forsyth Major was fortunate in obtaining a nearly complete skeleton of *Hippopotamus madagascariensis*, which is now set up in the British Museum Geological Gallery, and was photo-engraved in 1902 and described by the discoverer. Like *H. liberiensis*, it is a pigmy form of the great *H. amphibius* of Africa. Besides the above there are in the Mediterranean islands *H. Pentlandi*, *H. melitensis*, and *H. minutus*, all pigmy forms. In 1903 the same author wrote on some new Carnivora from the Middle Miocene of La Grive Saint-Alban, Isère, France, and defined *Progenetta certa*, *Leptoplesictis* sp., *Trocharion albanense*, and *Trochictis Depreti*.

Numerous mammalian remains from Egypt have from time to time been sent by Captain Lyons, the Director-General of the Geological Survey, to the British Museum for determination, and Dr. C. W. Andrews during the last five years visited Egypt several times in order to collect further material, which he has described in a series of papers. In 1899 he noticed and figured *Brachyodus africanus*, a large anthracotheroid ungulate, of which a number of allied forms have been described from European deposits; he also mentions the remains of a small species of *Rhinoceros*.

Dr. Andrews made numerous expeditions with H. J. L. Beadnell to the western desert, which resulted in the discovery of a number of important mammalian remains of Zeuglodonts, Sirenians, and Proboscidea; of these may be mentioned *Eotherium ægyptiacum*, *Zeuglodon osiris*, *Palæomastodon Beadnelli*, *Mœritherium Lyonsi*, *M. gracile*, *Bradytherium grave*, and *Eosiren libyca*. Also from the Wadi-Natrun remains of a small hippopotamus, a hipparion, a small pig-like animal; various antelopes were also obtained, likewise remains of *Hippotragus Cordieri*.

In 1903 Andrews offered suggestions on the evolution of the Proboscidea, and described the gradual increase in the complexity of the molar teeth, the loss of incisors Nos. 1 and 3, and the great increase in size of incisor No. 2, which eventually formed the tusk; the canines are also early lost; in the earliest forms some of the cheek-teeth (milk-molars) are replaced by premolars in the usual manner from beneath, and these teeth remain in wear simultaneously with the true molars. In later forms no vertical succession takes place; as the milk-molars are worn they are shed, being replaced *from behind* by the forward movement of the molars. Of these also the anterior may be shed until, in old individuals of the later types, the last molar is alone functional. The molar teeth increase in

complexity from the earliest to the latest type, beginning as simple quadritubercular molars in *Mœritherium* and ending with the complex tooth found in *Elephas*; in *Palæomastodon* the molars are trilophodont, as are the first and second molars in *Tetrabelodon*. In the Stegodonts a further increase in the height of the crests of the molars takes place, the teeth being covered by a thick coat of cement; in still later forms these crests become highly compressed laminæ united by cement; as many as twenty-seven plates being present in one tooth in the Indian elephant.

By these researches we are made acquainted with a series of forms in the direct ancestral line of the Proboscidea, taking as (1) *Mœritherium*, Middle Eocene; (2) *Palæomastodon*, Upper Eocene; (3) *Tetrabelodon*, Miocene; (4) the Stegodonts, Pliocene; (5) the Mammoth, *Elephas primigenius*, Pleistocene; and (6) the living Indian elephant.

In the same year Andrews gave an account of further discoveries in the Fayûm, Egypt. The commonest forms met with were *Palæomastodon* and *Arsinoitherium*. A fine skull of the latter and of *Mœritherium* were obtained; the author also described and figured *Megalohyrax eocænus* and *Pterodon africanus*.

Professor E. D. Cope gave an account of a new type of Perissodactyle Ungulate, *Phenacodus primævus*, from the Eocene of Wyoming, U.S.A., believed to be a primitive ancestor of the horse. In 1899 Cope discussed the development of the Proboscidea, but the discoveries made by Andrews more lately in Egypt give us fuller information on this subject.

P. M. C. Kermode gave in 1898 some interesting particulars of the exhumation of the gigantic Irish deer in the Isle of Man; the first specimen, having been obtained at Ballaugh in the Isle of Man, was in 1819 and is now preserved in the Edinburgh Museum; the recently discovered specimen has been set up in Douglas Castle.

Should our retrospect of the life-history of the Geological Magazine in the past forty years seem hardly to justify so large a space having been devoted to it, nevertheless we may plead that it serves to show what an important part this journal has taken, and still takes, in the progress of geology and palæontology, not only in this country and in our colonies but abroad generally, whilst the splendid list of eminent men among its contributors still stands unrivalled. In the matter of illustrations we have a right to feel proud. Seven hundred excellent plates adorn the journal, and seventeen hundred illustrations will be found in the text.

The increase in recorded fossil remains has been enormous, but the increase in names and the changes brought about in their application have been even far greater. We have only to compare A. S. Woodward and Sherborn's Vertebrata with that part of Morris's Catalogue (1856), or to consider for a moment the great additions made to our Oolitic species of Gasteropoda recorded by Hudleston of late years since Professor Morris's time.

After all, it is not the length of the palæontological road which is so trying, but its inequalities. For example, how can the perplexed

student follow the zigzag and tortuous nomenclature of the Ammonites, as he views them to-day by the light of modern writers on this group? Or, to take a less perplexing branch, the British non-marine Mollusca (as recorded by B. B. Woodward, 1903). What becomes of our knowledge, derived from the past, if out of 167 names defined by Forbes and Hanley, only 51 remain intact? Such metamorphoses are too startling.

One pressing matter remains to be mentioned, that is, a GENERAL INDEX to the forty annual volumes of the GEOLOGICAL MAGAZINE.

The Index is prepared in MS. by Mrs. Woodward. The question is, *shall it be printed?* If, say, 300 of our readers are prepared to subscribe one guinea each for a copy, this work of reference might be published. It would unquestionably prove of the greatest value to all workers in geology and palæontology.

Every year Time strikes off some name from our list of old and valued friends, and each year gives us some new ones to add, but we crave *more* subscribers in order to be able to give more illustrations and so add new interest to our journal. In conclusion, we trust that the fifth decade may be brighter and more successful than the four already completed, for our readers and subscribers as well as for our kind-hearted and always encouraging and helpful friend the Publisher, and lastly for ourselves that we may be permitted to witness the Jubilæum of the GEOLOGICAL MAGAZINE.

H. W.

II.—FURTHER NOTES ON THE MAMMALS OF THE EOCENE OF EGYPT.

By C. W. ANDREWS, D.Sc., F.G.S., British Museum (Natural History).

PART II.

(PLATE VI.)

Arsinoitherium.

THE *skull* of one species (*A. Zitteli*) of this remarkable ungulate has already been figured by Mr. Beadnell, and also in this Magazine (December, 1903), where its general form is well shown. Details of the structure of the skull and skeleton will be given in the monograph, so that only a few of the more important characters need be referred to here.

The pedunculate occipital condyles are very large and prominent; the occipital surface slopes strongly forwards and is bordered by a massive lambdoidal ridge, which on either side (in old animals at least) rises into a prominent backwardly directed boss of bone, almost like a blunt horn. The parietal region of the cranial roof is flat and is at right angles to the side walls of the skull, being sharply marked off from them by well-defined ridges, which form the upper limits of the temporal fossæ. The suture between the parietals is obliterated in the youngest skull examined. The pair of small posterior horns over the orbits are borne exclusively by the frontals, while the great anterior pair seem to be formed entirely by the enormously developed nasals.

The squamosal takes a large share in the formation of the side

wall of the cranium. It bears a large post-tympanic and also a large post-glenoid process, the two approaching one another, though not meeting, beneath the auditory meatus. The glenoid surface is very broad from side to side, but narrow and deeply concave from before backwards. The orbits are not marked off in any way from the temporal fossæ; there are large antorbital foramina. The pre-nasal buttress of bone, running from the premaxillæ to the nasals and helping to support the front of the great horns, seems to be formed mainly by the premaxillæ. The pterygoids form extremely large palatine plates, and the palate is very deeply concave from side to side, particularly in front.

In the *mandible* the ascending ramus is high, and the coronoid process rises considerably above the transversely elongated condyle.

The *teeth* (Plate VI, Figs. 1–3). The dental formula is i. $\frac{3}{3}$; c. $\frac{1}{1}$; pm. $\frac{4}{4}$; m. $\frac{3}{3}$. The tooth series is closed, and in the mandible at least the crowns all wear to a common level, and there is no clear line of distinction between the premolars, canines, and incisors; but, on the other hand, in both upper and lower jaws the difference between the premolars and molars is most striking. The molars are especially remarkable for the height of their crown, particularly on the outer side. Each molar (see Figs. 1 and 3) consists of two columns (*pc.* and *ac.*) flattened antero-posteriorly, and with the posterior face slightly concave from side to side. The enamel-covered portion of the outer side of these elements is very much higher than on the inner side. These main columns are united on the inner side of the tooth only, where also are developed the smaller accessory crests marked *x* and *y* in the figures. In wear (see m. 2 of Fig. 1) these accessory elements, together with the inner ends of the main columns, unite to form an inner wall, which, except just at first, is not covered with enamel (Fig. 1). The premolars present a totally different appearance. In them there is an outer wall covered with enamel and consisting of two, or more probably three, united elements. There are two inner cusps, the anterior of which soon becomes united with the ectoloph, as in very worn teeth the posterior one does also; anteriorly the element marked *x* in the molar is present. The peculiar arrangement of the roots in the cheek teeth and the probable homologies of their cusps will be described later. It seems probable that we have here an extreme modification with great hypselodonty of one of the types occurring among the earlier Amblypoda. The canines and two posterior incisors are simple columnar teeth with a cingulum on the inner side, wearing to a flat surface continuous with that of the cheek teeth. The anterior pair of incisors are not well known to me, but they appear to have been separated by a considerable interval in the middle line, and to have possessed curved and pointed crowns with a shelf-like development of the cingulum posteriorly.

The lower molars are at first bilophodont, each consisting of a pair of obliquely transverse crests, the anterior faces of which are slightly concave from side to side and not covered by enamel. The outer angle of the posterior crest is united by a ridge with the inner

angle of the anterior one, from the outer angle of which another ridge runs forwards and inwards to the anterior face of the tooth. The pattern assumed in wear is shown in Fig. 2. These molars in some respects resemble those of some species of *Coryphodon* (e.g. *C. simus*[1]), but are more hypselodont.

The premolars are much more compressed laterally than the molars; they seem to consist essentially of a pair of crescents, but the details of their structure cannot be discussed here. The canines and incisors are simple columnar teeth wearing to a common level and forming a closed series both in the middle line and with the premolars. Altogether the dentition in this genus seems to be one of the most remarkable known, at least among the Ungulata. The teeth here specially referred to and figured are those of the type-specimen of *Arsinoitherium andrewsi*, Lankester.

The skeleton is almost completely known, but in the case of some of the bones there may be some danger of confusion with those of *Palæomastodon*.

The axis has a blunt peg-like odontoid process; its centrum and still more those of the cervical vertebræ behind it are very broad and short, so that the neck must have been nearly as short as in the elephants.

The scapula is much like that of *Dinoceras* as figured by Marsh in his monograph of the Dinocerata.

The humerus differs considerably both from that of *Elephas* and of *Dinoceras*. It is especially remarkable for the extreme antero-posterior compression of the lower part of its shaft and distal end, and for the presence of a very prominent deltoid process.

The radius and ulna are very short and stout, and do not differ widely in their main features from those of *Elephas*, while in some points, e.g. the distal articulation of the radius, they are unlike the corresponding parts of *Dinoceras*. The distal articulation of the ulna is still larger in proportion to that of the radius than in the elephants. In these latter, in some cases, the lunar has a surface for the trapezoid as well as for the magnum, there being apparently some displacement of the proximal row of carpals to the pre-axial side, instead of post-axially as usual. Whether this is so in *Arsinoitherium* or not in the case of the lunar is not known at present, but there is some evidence that the cuneiform extended pre-axially a short distance over the magnum. Weithofer ascribes the peculiar displacement in the elephants to the preponderating size of the ulnar articulation, and the same cause may have been efficient here.

The short stout metacarpals are somewhat displaced outwards; the third has a small contact with the unciform which entirely supports the fourth and fifth.

The femur is chiefly remarkable for the great antero-posterior compression of its shaft, the outer border of which is a thin sharp edge without any distinct projection representing the third trochanter. The distal articulation is much as in *Dinoceras*.

[1] See Osborn, "Evolution of the Amblypoda," pt. i: Bull. Amer. Mus. Nat. Hist., vol. x (1898), p. 192, fig. 16.

The tibia is extremely similar to that of *Dinoceras*.

It is in the tarsus that the relationship with the Amblypoda is most apparent. The astragalus in general shape is much like that of an elephant, but closer examination shows that its distal articulation is divided by a well-marked ridge and angle into two surfaces, one, much the larger, for the navicular, the other for the cuboid. Internal to the navicular surface there is a small facet which seems to indicate the presence of a distinct *tibiale*. In all essential respects the astragalus is very nearly like that of *Coryphodon* or *Dinoceras*. The calcaneum is very short and stout; there is a large fibular facet, and the surface for the cuboid is small. A navicular attributed to this animal is very similar to that of *Coryphodon*. Detailed descriptions and figures of the foot-bones and other parts of the skeleton will be given in the monograph.

The dimensions of the figured specimens (Figs. 1 and 2) are:—

Length of upper molar series	23·5 cm.
Length of the three posterior upper premolars ...	11·5 ,,
Length of lower molar series	23 ,,
Length of lower premolar series	11 ,,

All that is at present known of the structure of *Arsinoitherium* leads me to believe that it is a highly specialised, probably terminal, member of a subdivision of the Amblypoda, probably most nearly related to the Coryphodontidæ, though belonging to a separate family, the Arsinoitheriidæ. I am also inclined to think that *Barytherium*, though widely different in many respects, may have somewhat similar relationships, and may belong to still another family of the same sub-order.

Geniohyus mirus, gen. et sp. nov.

During the season 1902–3 a large part of the right ramus of the mandible of a pig-like animal was collected by Mr. Beadnell. This specimen, which is the anterior part of the right ramus of the mandible together with the symphysis, presents some very remarkable characters. The symphysial region is narrow both from side to side and from above downwards and behind it, just where the rami begin to diverge; the ventral border of the jaw is produced downwards on either side into a long decurved and backwardly directed process of bone, quite unlike anything I am acquainted with in any other animal. The hinder border of the base of this process is connected with the outer edge of the ramus itself by a thin plate of bone. The ramus is incomplete ventrally, but was evidently very narrow from above downwards. The function of this remarkable paired ventral process is very doubtful, but possibly it may have served as a protection for the projecting portion of a long upper tusk like the similarly situated process on the mandible of the *Dinoceras*.

The molars and premolars are in an excellent state of preservation, the only part wanting being the greater portion of the talon of m. 3. The characters of the molars are those of a primitive member of the Suidæ in which the selenodont character of the outer cusps is very well marked. Each molar consists of two pairs of cusps.

the outer one of each pair being distinctly selenodont. In the first molar the antero-external cusp is somewhat worn. It consists of the main tubercle, which is the apex of a V of which the arms are slight ridges, which rise at their ends into small tubercles; of these the anterior is situated on the anterior border of the tooth, while the posterior is connected by a slight ridge with the postero-external angle of the inner cusp. The postero-external cusp shows the selenodont character still more plainly: its small anterior accessory tubercle partly closes the main transverse valley; the posterior accessory tubercle is on the hinder border of the tooth. The internal cusps are trihedral in form, so that in wear they also show a tendency to a V-shaped surface, the opening of the V of the anterior cusp looking backwards and outwards, that of the posterior forwards and outwards. There is a slight development of the cingulum on the outer side of the tooth, most marked opposite the opening of the transverse valley and near the anterior end of the tooth. The next molar is similar, except that on the hinder border there is a minute additional tubercle lying internal to the posterior accessory tubercle of the posterior cusp. In the last molar the structure is similar as far as it is preserved, but the talon is almost entirely wanting.

The *premolars*. The anterior premolar is a compressed tooth consisting of small anterior and posterior tubercles and a high main cusp. In the next there is a small cingular ridge in front of the tooth, and the main cusp is much larger and shows a tendency towards division into an outer and an inner tubercle. In wear it gives a triangular surface, from the outer angle of which a ridge runs down the outer face of the tooth, while from its front angle there is a small ridge connecting it with the anterior cusp, and similarly posteriorly a small crest unites it with the posterior cusp. The next tooth is similar, except that the posterior lobe is larger and shows a tendency to give a V-shaped surface in wear. In pm. 4 the division of the main cusp is complete; the inner element is small and rounded, the outer larger and V-shaped in wear. From the anterior point of the V a ridge runs to the small anterior cusp, while from the posterior a low ridge unites it with the anterior limb of the V-shaped hinder lobe. To the inner side of this last there is a trace of an inner cusp corresponding in position to the postero-internal cusp of the molar. This remarkable mammal is clearly entitled to generic distinction, and it may be called *Geniohyus mirus* in allusion to the remarkable character of the process on its mandible.

The dimensions of the teeth in the type-specimen are:—

	Length.	Breadth.
pm. 1	12 mm. ...	7 mm.
pm. 2	12 ,, ...	9 ,,
pm. 3	13 ,, ...	10 ,,
pm. 4	13 ,, ...	11 ,,
m. 1	15 ,, ...	11 ,,
m. 2	17 ,, ...	13 ,,
m. 3	? ,, ...	15 ,,

Geniohyus fajumensis, sp. nov.

Another specimen, consisting of a portion of the mandible containing the premolars in a perfect state of preservation, was also collected. This may be taken as indicating the existence of a second species of *Geniohyus*, since the teeth, though similar in general form, differ considerably in many details. The chief of these differences are that the main cusp is already distinctly divided in pm. 2, and the hind lobe in all the teeth is much larger and more distinctly selenodont.

The structure of the teeth is as follows:—Pm. 1 is strongly compressed with a very small anterior cusp and a high main cusp, from which three ridges diverge posteriorly, one running down the outer face of the tooth, a second back to the anterior arm of the V-shaped posterior cusp, the third inwards down the inner face of the tooth. The posterior lobe is distinctly selenodont.

In pm. 2 the anterior cusp is larger, and the ridge running inwards from the main cusp bears a small tubercle at its inner end. The posterior lobe is larger than in pm. 1. Pm. 3 has a larger anterior tubercle, and the cusp on the inner side of the main cusp is now nearly as large as that element and is clearly separated from it. The posterior V is still larger. Pm. 4 is similar, except that the small anterior cusp is doubled, the posterior lobe is still larger, and there are traces of a small postero-internal cusp.

The dimensions of the premolars are:—

	Length.		Breadth.
pm. 1	13 mm.	...	7 mm.
pm. 2	13 ,,	...	8 ,,
pm. 3	15 ,,	...	10 ,,
pm. 4	16 ,,	...	12 ,,

EXPLANATION OF PLATE VI.

Fig. 1.—Left upper molars and premolars of *Arsinoitherium andrewsi*, Lankester.

,, 2.—Left lower molars and premolars of the same.

The two specimens figured belong to one individual, which is the type of the species. About one-fourth nat. size.

,, 3.—Outer face of last upper molar of the left side of *Arsinoitherium zitteli*, Beadnell.

In Figs. 1, 2, and 3: *a.c.* anterior column of molar; *p.c.* posterior column of molar; *x*, anterior inner cusp; *y*, posterior inner cusp.

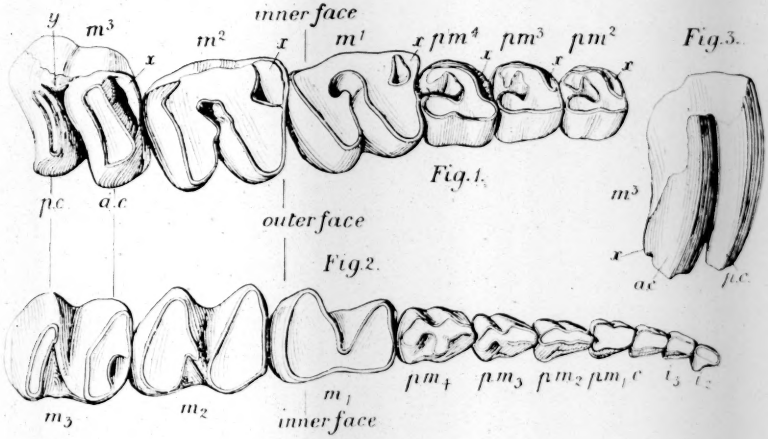
,, 4.—Upper and side views of part of the mandible of *Geniohyus minus*, gen. et sp. nov. Type-specimen. About two-thirds nat. size.

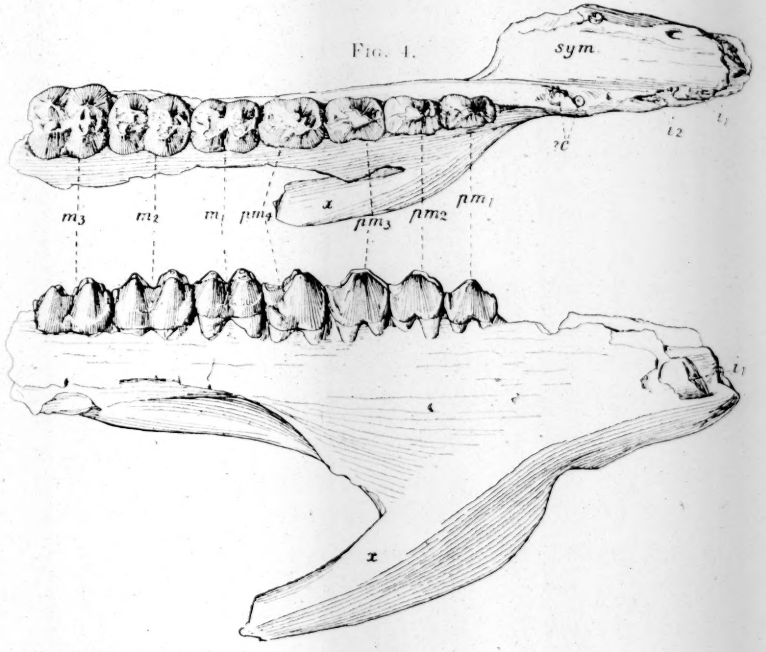
sym. symphysis of mandible; *x*, backwardly directed process on lower border of mandible.

III.—Note on the species '*Am. plicatilis*' and '*Am. biplex*' of Sowerby.

By Rev. J. F. Blake, M.A., F.G.S.

The old question of the proper interpretation of these names, which was raised by Professors Nikitin and Pavlov, after their visit to this country for the Geological Congress in 1888, to whom no reply was made, for their conclusions could scarcely be denied, has been raised again by Miss Healy in a communication





G. M. Woodward del.

Mammals of the Eocene of Egypt.

to the Quart. Journ. Geol. Soc., Feb. 1904. As these conclusions do not appear to be well known, it may be as well to quote them. Nikitin[1] says: "Having found in the British Museum the original of *Am. biplex*, Sow. (tab. 293, fig. 1), I assured myself that that original presented absolutely the Oxfordian form of *Perisphinctes* of the group of *P. plicatilis*, by the character of its numerous straight rounded ribs, by the mode of enrolment, by the constriction of its perfectly visible whorls, and lastly by the matrix; it showed no resemblance to the Kimmeridgian and Portlandian forms described in France and England under this name . . . Mr. Loriol had not seen the original of Sowerby . . . but having received from England, under the name of *A. biplex*, Sow., the Portlandian forms, he was justified in giving this name to the same form from Boulogne. On studying the English Kimmeridgian forms placed in the museums of England under the name of *A. biplex* I found amongst them the typical form of *A. Pallasi*, D'Orb."

Professor Pavlov deals only with the latter species,[2] saying, "*Perisph. biplex* (*Pallasianus*) is the commonest form of our *virgatus*-beds, and its synonymy with the English form has for a long time been recognized"; and again, "Amongst these fossils [enumerated by Phillips] *Am. biplex* can, according to all appearances, be placed in synonymy with our *Perisph. Pallasi*."

These, then, by the concurrence of two well-qualified observers, may be considered settled points in any revision of our Upper Jurassic Ammonites. But it may well be asked how came so many English geologists thus to misname their own species. It would appear to have been in this way. Geologists of old cared less for the names than for the specimens themselves, and when Fitton[3] submitted his fossils to J. de C. Sowerby, the son of J. Sowerby and successor in the Min. Con., and was told that the characteristic Ammonite of the Kimmeridge Clay and Lower Portland was called *Am. biplex*, it became so to him, and to all who followed him, without inquiring into the name. This name being thus occupied, Phillips used for the common Malton fossil the other name,[4] as the only one unoccupied, referring to a somewhat similar and not well-distinguished Ammonite. It thus became '*Am. plicatilis*,' and was so understood even by Nikitin himself.

Leaving, however, names alone, which, though useful, may sometimes mislead us, it is common knowledge that one species figured by Loriol, Damon, Phillips (Geol. Oxf., pl. xv), and Woodward, is characteristic of the Upper Kimmeridge, while another species, figured by Sowerby in pl. 293, figs. 1, 2, is the characteristic fossil of the Coralline Oolite; but as to the species figured by him in pl. 166, it has never to my knowledge been found *in situ*, so that its exact horizon is not known. This being the state of affairs, we will see how much further we are carried by the observations of Miss Healy.

[1] "Excursions dans les Musées, etc., de l'Europe occidentale": Bull. Soc. Belge Géol., tom. iii.

[2] "Etudes sur les couches Jurassiques et Crétacées de la Russie."

[3] "Strata between the Chalk and the Oxford Oolite."

[4] "Geology of Yorkshire," p. 102.

With regard to Sowerby's *Am. plicatilis*, we seem as much in the dark as ever. We cannot be sure that the type has been found. The specimen figured by Miss Healy is one which "bore no label," and it by no means appears to be the original specimen when we can "compare it with Sowerby's original figure"; though perhaps the presence of "a few crystals of carbonate of lime about it" could prove that it *is* the type; nor can we even be certain that it belongs to the same species, though this may be probable. If there is one thing on which Sowerby may be depended, it is to give indications by which his specimens may be recognized. He seldom, if ever, 'restores' his pictures; but in this case we find a broad band along the periphery which he would have to imagine, he has made the bifurcations originate often towards the inner half of the whorl, he has run them quite across some suture-lines and has omitted all suture-lines except those at the end, even omitting to mark two deep holes which are left by them, and he has added even a projecting keel beneath the siphuncle, though this may be from another specimen. Nevertheless, the description is also at variance with the figure, but agrees better with the description of *A. biplex*, as shown by placing the latter in italics beneath it.

Discoid radiated, sides flat, front round, plain in the centre.
Discoid costated, sides depressed, front is round.

volutions exposed, radii numerous, equal, straight.
volutions exposed, costæ numerous, small, nearly straight.

furcate, aperture square with rounded angles.
split over the front, aperture oblong, narrower near the front, which is round.

The radii do not branch till they begin to turn over the front.
Costæ are divided into two branches a little before they pass over the front.

in the centre of which they are nearly obliterated.

It is seen that the main difference indicated is in the character of the centre of the periphery, but somewhat similar features may be seen in some of those corresponding to tab. 293. I think, however, they are specially characteristic of shells of the type of tab. 166 (though they seem to be referred by Miss Healy to wearing only); for the ends of the half ribs are obscurely seen in the photograph to be swollen on each side of the median line; the other differences are mismatched, as:—'small' for 'equal,' 'nearly straight' for 'straight,' and 'a little before' for 'not till they begin.'

We shall never know for certain where Sowerby's figured specimen came from till one like it has been discovered *in situ* in the same sandy stratum at Dry Sandford or Marcham with the several associates recorded, including '*Am. excavatus*,' but Phillips says nothing about that locality, and speaks only of Headington. Meanwhile the new figure most resembles two specimens in my collection from the summit of the Trigonia-beds of Weymouth (whence, in fact, Buckland may have brought his unlabelled specimen), in which case it represents the highest zone of the local Corallian. Its nearest foreign equivalent, already recognized in the British Islands, is *Am. Achilles* of D'Orbigny (Terr. Jurass., pl. 206), which

shows when young the same peculiarity of the periphery, and whose sutures, as drawn in the adult, show the same kind of development as one might expect from the smaller examples, provided that both figures really belong to one species. With regard to Sowerby's figure on tab. 293, fig. 1, matters are plainer: it represents, as already stated, the typical form of the Yorkshire fossil known as *Am. plicatilis*, acknowledged to be so from the intended representation of it in pl. iv, fig. 29 of the 3rd edition of the "Geology of Yorkshire," revised by R. Etheridge; it corresponds also to Sowerby's *description* of *A. plicatilis* of tab. 166, which, as already noted, so far agrees with that of tab. 293, fig. 1. It was for this reason I supposed Sowerby's specimens had probably been interchanged, being guided by Agassiz's translation of his work, but Miss Healy has drawn attention to the character of the matrix, which I had entirely overlooked, which puts an end to this idea and at the same time opens up new considerations. By no possibility could any fossil in such a matrix be found in any bed at Dry Sandford, nor in any of the Corallian beds at Headington. The fossil in itself is, however, perfectly normal, but it has been separated septarially along a calcite-filled crack running principally nearly parallel to the median plane. This has raised the upper surface and separated the lower, as pointed out to me by Mr. Crick; but the small central portion is quite continuous with the outer whorls, on the upper side at least.

But the problem is, where to find a septarian matrix containing a Corallian fossil. Looking over all the fossils referred to Corallian or Oxfordian strata in the British Museum, one only was noted with a similar, very similar, matrix. It was the matrix of '*Am. varicostatus*,'[1] and the locality given was "Hackleton," which is in a drift-covered district about 5 miles from Northampton towards Bedford or 15 miles from Hawnes. My own purchased specimen, locality unknown, but horizon stated as "Oxford Clay," and perfect to the centre, has also been preserved in a septarium.[2] The specimen of Sowerby's pl. 293 has evidently been knocked out of a similar rock, and the second fragment has a similar matrix.[3] On the other hand, we may naturally look for such specimens in localities where Corallian rocks are represented by clays, and especially where septarian doggers are recorded as occurring. Such are found near the summit of the Corallian clays at Ampthill (see Woodward, "Jurassic Rocks of Britain," vol. v, p. 136).

From these considerations we may safely conclude that the fossils figured as *A. biplex*, but usually called *A. plicatilis*, are the inside whorls, very likely broken out of the middle, of larger specimens called *A. varicostatus*. The latter retain the old age characters, though such characters are common to several species. There

[1] The spelling of Buckland, probably an oversight, as corrected by Phillips.

[2] Supposed at first to be from Osmington, but this shows that it was not so.

[3] After the proof afforded by Mr. Crick of the Cornbrash age of *Nautilus truncatus*, stated by Sowerby to be from the Lias of Keynsham, we cannot place too much reliance on the localities given by the latter.

is the same association of inner and outer whorls at Headington, Malton, Pickering, and elsewhere, at least in different specimens. The most perfect representation of this species is the figure given by D'Orbigny under the name *A. biplex* on tab. 191, 192 of the Terr. Jurassique, corresponding in every respect down to the smallest size with my own specimen.[1] It corresponds also with the sutures as drawn by Miss Healy, if these were taken from the opposite side of the shell, were drawn in the usual manner with the lobes pointing downwards, and shaded dark in contrast with the saddles. The suture-line is rather remarkable for the breadth of the dorsal saddle, and I doubt it would ever broaden out from such as characterize *A. plicatilis* of Sowerby, though we must allow *some* liberty to the poor Ammonites while growing.

As to the name that is to be applied to this fossil, I must leave that to those who are more interested in the question, for there is plenty of choice. If we could be sure that *Nautilus colubrinus* of Reinecke, which came from Staffelstein, had an old age like that of ours, its name might be the earliest (1818); on the same condition *A. planulatus* of Schlotheim might be the next (1820). Sowerby's name of *biplex* was the earliest English name (1821), but it included only the earlier whorls. *Am. instabilis* of Phillips (1829–35) was the next, but it was not very fully described and it was unaccompanied by a figure.[2] Buckland in 1836 gave the first complete description and figure as *A. varicostatus*. D'Orbigny, in 1846 (?), figured it as *A. biplex*, but described it in the text as *A. plicatilis*; and finally Oppel in 1862 divided it and gave the name *A. Martelli* to the perfect form. For myself I think that the use of Buckland's name, though it has not the priority, would cause the least confusion, in which case both of Sowerby's names might become obsolete, as ill-distinguished and of doubtful reference. Possibly the object of nomenclature may not be, after all, the establishment of the earliest and least understood names, but the prevention of confusion as to what you are talking about.

IV.—Further Notes on the Trias of Devonshire, with special reference to the Divisional Line between the Bunter and the Keuper in that region.

(Reply to some Criticisms by Mr. Alexander Somervail.)

By Alexander Irving, D.Sc., B.A.

MR. ALEXANDER SOMERVAIL has been so good as to send me lately a paper read by him before Section C of the British Association at Southport, September, 1903, and printed in the Geological Magazine, Dec. IV, Vol. X, No. 472, October, 1903. The paper contains certain criticisms on the published work of

[1] It is marked as triplicate, but obviously it is usually biplicate.

[2] In 1874, in the 3rd edition of the "Geology of Yorkshire," this name was abandoned for Buckland's, reference being made to "pl. xiv, fig. 10," but the reference is obviously to the "Geology of Oxford," where it is figured with Buckland's name in the legend.

Professor Hull, F.R.S., and myself among the Red Rocks of the South Devon coast, with especial reference to "the Base of the Keuper in South Devon." I desire to reply here to Mr. Somervail, and in so doing shall have to refer frequently to the three papers of my own published in the Quarterly Journal of the Geological Society in the years 1888, 1892, 1893, and to the paper by Professor Hull in the same Journal in the year 1892. For the sake of convenience and brevity I will refer to these papers by certain letters, as below.[1]

Mr. Somervail states (p. 460): "There is only one point in which I differ from these authors; it is in relation to the rocks forming the base of the Keuper in this area." He states further that "in the last of these papers both authors agree to regard certain breccias occurring at the mouth of the river Otter, and again at the mouth of the Sid on its eastern side, as the basement beds of the Keuper." This is not quite an accurate statement, seeing that the base of the Keuper along the Otter Valley was definitely worked out by me after Professor Hull's paper (H) was published, and the results given in paper C a year later. In the discussion which followed the reading of paper C at the Geological Society Professor Hull repeated his assent to my reading of the district so far as the basement-line of the Keuper was concerned; and at the same time gave up his previous contention that the great marl series of the district further west, and below the Budleigh Salterton Pebble-bed, was the representative in the Devon area of the Lower Bunter of the Midlands and the Severn country.[2]

Mr. Somervail tells us that I have described the breccias near the mouth of the Otter "as calcareous or dolomitic breccias or conglomerates." Here there are two slight inaccuracies; for (1)

[1] (A) A. Irving, "The Red Rocks of the Devon Coast-Section": Q.J.G.S., vol. xliv (May, 1888).
(B) ——— "Supplementary Note on the Red Rocks of the Devon Coast-Section": Q.J.G.S., vol. xlviii (Feb. 1892).
(C) ——— "The Base of the Keuper Formation in Devon": Q.J.G.S., vol. xlix (Feb. 1893).
(H) E. Hull, F.R.S., "A Comparison of the Red Rocks of the South Devon Coast with those of the Midland and Western Counties": Q.J.G.S., vol. xlviii (Feb. 1892).

[2] In a letter to me afterwards Professor Hull went even further, and declared himself inclined to view, in the light of these later facts, all the so-called Lower Bunter of the Midlands as more closely related to the Permian than the Trias. For my part, I should, in the light of my work in Central Germany in 1883 (see Q.J.G.S. for August, 1884), hesitate to go so far as that. It would tend to drag us back into the Murchisonian confusion of thought, arising from insufficiency of observation, which it was the definite purpose of that paper (and of one supplementary to it in the GEOL. MAG. of that year) to clear away. My contention was, and is, simply that the marl series of Devon are the equivalents of the identically similar marls, which are interbedded with the Magnesian Limestone beds of the Permian in the regions to the east of the Pennine Chain, and conspicuously so in Notts; and that the Lower Bunter of the Midlands is wanting in the basin south of the Mendip Axis, even as Professor Hull, in his work on "The Permian and Triassic Rocks of the Midland Counties," has shown it to be wanting in various successions in the Severn country, to which references are given in my papers. See further my paper "Twenty Years' Work at the Younger Red Rocks" (GEOL. MAG., August, 1894).

I have never described (I believe) the breccias as 'dolomitic,' and (2) I am not aware that I ever spoke of them as 'conglomerates'; on the contrary, I took particular pains in recording my close observations of the *breccia* at the Otter mouth (A, p. 153) to show that it could not be called a conglomerate, on account of the extreme paucity of rounded included fragments. Further, I had no evidence of the presence of magnesium carbonate in the rock, without which the term 'dolomitic' would not be justified.

We come now to the main point. Mr. Somervail goes on to say: "This description *certainly does not* apply to the alleged breccias on the left bank of the Sid," emphasizing by italics this categorical denial. This requires severe examination.

Mr. Somervail's caricature of my description of the breccias (*supra*) does not apply with scientific precision to either of them at the mouth of the Sid or the mouth of the Otter; but my description applies to them at both places, although at the Sid there is just this difference, that the breccia is not so massively developed, and is not quite so strongly calcareous, owing probably to the fact that the carbonate of lime has been partly leached out from the matrix by longer exposure. I have, as I write, lying before me *six specimens of the breccias in question*,[1] which were labelled at the time when my work in Devon was done, and have only lately been again brought to light. Four of these are labelled "Basal Breccia of the Keuper, left bank of the Otter," and on two of these is written the reference "Q.J.G.S., vol. xliv, 153" (paper A); the fifth is labelled "basal breccia of the Keuper at Harpford"; and the sixth is labelled "Calcareous breccia, base of the Keuper, mouth of the Sid." Of these specimens, as judged by the rough test of the same dilute acid, the one from Harpford and two of those from the Otter mouth are very strongly calcareous (one, indeed, to such an extent that the matrix is in places macrocrystalline); the specimen from the mouth of the Sid effervesces rather less strongly with the acid than those, but more strongly certainly than the remaining two specimens from the Otter mouth. Again, a comparison of them reveals the fact that while the breccia-structure of the specimen from Harpford and of two of those from the Otter is more conspicuous than in that from the Sid (owing to the larger size of the contained fragments), in the remaining two from the Otter that is not the case. I need not repeat here what I wrote some fifteen years ago as to my hesitation to fix upon the Sid breccia as the base of the Keuper at that spot, until confirmed in that view by so experienced an observer as Professor Hull, who brought to the subject his trained experience of more than twenty years' work in the Red Rock Series of the Midlands and the Severn country. But I may add that, in my annotated copy of paper A, I find the following marginal note, made at the time of my visit with Hull:—"There is a more definite breccia (true base of the Keuper) forming the shelf of rock, on which the ladder rests at the eastern end of the foot-bridge across

[1] These were exhibited at the meetings of the Geological Society when my papers were read.

the Sid. It contains fragments of grit and quartzite, and is calcareous."[1]

So the bed described by Professor Hull (H, fig. 2) as "a basement-bed of hard calcareous breccia" may be seen to be no fiction, as is implied in Mr. Somervail's remarks. The hammer told me it was *hard* as compared with these red rocks in general. Recollecting that the rocks which furnished the fragments lay probably to the westward, we should expect to find the brecciated structure less pronounced, and the rock itself more feebly developed, as we work eastwards.

Mr. Somervail makes a remark in his paper (p. 460) as to difference of the line of strike of the beds in the Otter and the Sid valleys. That is, however, but a glimpse of the obvious, it adds nothing to evidence either way and need not detain us.

He goes on to say: "The Otterton breccias are not again brought up . . . . at the fault at the Chit rock." Of course they are not found there on the east side of the fault, but that rock—as both Hull and I have recognised, and as sections in and about Sidmouth show to an unprejudiced observer—*is Bunter*, and therefore at a lower horizon in the series. They do not, however, "occupy a much lower horizon," though they are hidden (doubtless) underground some distance below sea-level, as my reading of the section implies, on the western side of the fault; and they crop out in the Otter Valley two miles to the west at about 70 feet O.D. at places mentioned in paper C, just as we should expect, when the faulting visible in the cliff-section (to which I have drawn attention in my three papers) and the slight easterly dip of the Lower Keuper beds between the Chit Rock fault and the Otter are allowed for. Mr. Somervail appears to have overlooked the faulted synclinal (A, p. 152) visible in the Keuper strata to the west of the Chit Rock fault; but even allowing for that, I do not think I have greatly over-estimated the fault-throw at the Chit itself, with its mural western face; the estimation being based on a comparison of what is seen at the Chit Rock and to the west of it, with what is seen in the open daylight succession in the cliffs to the east of the Sid; and I venture to say there need be no great difficulty in establishing the identity of horizons on both sides of the valley in which Sidmouth lies if the observations recorded in my paper A (pp. 150, 152) are duly considered. It is extremely unlikely that, if we could restore the strata which have been destroyed in the erosion of the intervening valley of the Sid, and restore the rocks on either side of the fault to their original planes of deposition, we should find the 150 feet or so of strata marked by calcareous concretions (A, p. 150) thinning out in such a series of strata to the

[1] I recollect noticing at the time how the mouth of the Sid was blocked by a dam of shingle, through which the water percolated in reverse directions at high and low tide. Is it worth while to ask it, in the course of fifteen years or so, this shingle-bank may not have been driven by tidal action further east, and covered up the lower portion of the section as Hull and I saw it, with the obliquely bedded Bunter Sandstone below the breccia? That question any resident in the locality can answer for himself.

few feet which Mr. Somervail's computation requires in a distance of less than half a mile, unless we assumed some great unconformity and overlap, of which there is no evidence so far as I know.

Mr. Somervail's statement (p. 461) "From Otterton Point *eastwards* these [the Otterton] breccias are overlain by a series of red sandstones," etc., is misleading. No such succession exists, since from Otterton Point the coast trends *nearly due north*, and therefore nearly along the line of strike of the beds. To truly estimate the thickness of that series—in which I have definitely recognised (paper C) the basement beds of the Keuper, with the Otterton breccia marking their downward limit—we must take a *section due west from the Chit Rock fault to the Otter*, a distance of only two miles, instead of that of four or five miles along the line of coast. No one has thought of applying (as he seems to suppose [1]) "the term breccia" to these sandstones, but near their base, in sections described by me in the Otter Valley (paper A, p. 153, and paper C, pp. 80, 81), they have the character, not of breccias, but of "brecciated sandstones," the contained fragments being sparsely scattered in the rock, while even the basal breccia itself is here and there repeated in them for a short distance in the upward succession. I have also noted (paper A, p. 149) that on the eastern escarpment of the Sid (above the breccia at that place) the same current-bedded sandstones (which in paper A were erroneously referred to the Bunter, but in paper C were referred to the Keuper basement beds) are "slightly brecciated," and contain subordinate "current-bedded breccias in a marly matrix, the contained fragments being mostly of indurated red marl." [2] These fragments may with little doubt be considered as derived from the red marls of the Permian; and their presence (if that derivation be admitted) tends to emphasize the stratigraphical break, as I have maintained in my papers as existing below the great pebble-bed, which runs inland from Budleigh Salterton, and constitutes the *terrain* of the Aylesbere Hills.

It is not clear to my mind what Mr. Somervail may mean when he says (next paragraph), "The effect of the fault at the Chit rock is to bring up . . . . the higher portion of these current-bedded sandstones." If he means that the Chit Rock is a portion of them, both Hull and I are at direct issue with him; if he does not mean that, it is difficult to see the logical force of the remark. Of course, the beds on the east of the Sid are "higher in the series" than those of the Chit Rock, according to the recognised succession of the Bunter and Keuper everywhere. At the bottom of p. 461 he seems to dogmatise as to the thickness of the sandstones east of the Sid, without, so far as I can see, any data as to the limit of their downward extension. Perhaps it may be useful to append here the

[1] Had he weighed the meaning of the footnote to p. 153 of paper A, he might have seen that it was intended to suggest an explanation of the "nobbly and concretionary structure" of which he makes mention. I observed it as a later development on the face of the cliff (?). Those familiar with the splendid natural sections of the Himlack Stone (Notts) will see the force of this all the better.

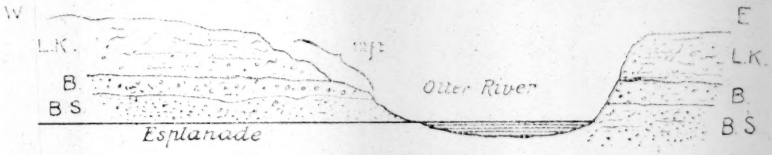
[2] From my notebook.

following note (transcribed from my notebook) made on the spot in September, 1887:—

"*Escarpment of the Sid.*—Massive false-bedded sandstones: intercalated marly beds, very strongly false-bedded and brecciated (mainly with indurated fragments of red marl). Just east of the Sid [in the coast-section] the same (marls more developed with pale-green layers); next sandstone of pale-grey colour (though reddened on the cliff-face by rain-wash) containing angular fragments of dark-red marl, the surfaces of these being grey, from the leaching out of the irony colouring matter."

Here we have a record surely of evidence indicating the gradual transition from shallower to deeper water at the time of deposition of the beds in question. These more or less brecciated false-bedded sandstones I take to be on the same horizon as those near the base of High Peak Hill, where in the Lade Rock they visibly underlie the more compact and massively bedded sandstones, so characteristic of the Lower Keuper, both in the Devon sections and in the Midlands (see paper A, pp. 150,[1] 151), and are in one or two places bored through by the surf. The same succession may be observed at Badfield's Point, beyond which, as we follow the coastline (trending in a S.S.W. direction), these irregularly bedded soft sandstones form

Section across the River Otter near Otterton Point, Devon.



L.K. Lower Keuper basement-beds, in which pebbles and fragments are sparsely scattered. B. Breccia. B.S. Bunter Sandstone.

the cliff-face all the way to Otterton Point. There we recognise below the breccias the reappearance of the Bunter beds, which are faulted up at the Chit Rock and described by me (see paper A, p. 153, and C, p. 81). Mr. Somervail (p. 462) speaks of these breccias as "only a small portion of still lower beds of the same nature seen on the west side of that [the Otter] river, and extending along the Promenade" at Budleigh Salterton. In this I am unable to follow him. In my notebook I find the accompanying sectional drawing across the Otter, made on the spot, which represents the breccia with the overlying brecciated sandstones as exposed on the same horizon in the Esplanade section. The beds below these I have already relegated to the Bunter of the section further to the west (paper A, p. 153). It reminds one of sections in the Nottingham district.

In conclusion, I cannot admit that Mr. Alexander Somervail has attained the object of his paper in showing "sufficient evidence for the conclusions that the Sidmouth section has been misread by

[1] There is a misprint in line 10, p. 150, where "more fully developed" should read "more feebly developed."

Professor Hull and Dr. Irving." By the irony of fate he has chosen for the reading of his paper the very place (Southport) at which a paper by the present writer (after a Summer's work in Germany) carried conviction to the mind of Professor Hull as to the true divisional line between the Permian and the Trias in England and on the Continent. See Report of the British Association, Southport Meeting, 1883.

Mr. Somervail has been good enough to send me also a copy of a paper read at Sidmouth last Summer.[1] There is much in that paper that one appreciates, and not much to criticise beyond what one has already dealt with. He seems, however, to speak of the 'Waterstones' as forming the base of the Keuper in the Midlands, which scarcely harmonises with the use of that term by previous writers, and notably by Professor Hull in his classic memoir on the Permian and Trias, to which reference has been made above. It does not reveal any intimate acquaintance on the writer's part with the Midland Red Rocks, or even with inland sections of the Devon series.

As to Mr. Somervail's failure and that of his "friend who was visiting Sidmouth" to find the breccia east of the Sid, no more remains to be said here, each reader being left to draw his own inferences. I must, however, traverse his statement that "the succession of beds above it" is not the same in both sections (of the Otter and the Sid). A perusal of the remarks in the foregoing paper will show why here I am also at issue with him. I admit that there is not such a full development of the false-bedded basement beds of the Keuper in the Sid section as in the Otter sections 2½ miles further west; but that is only a *quantitative* difference, not at all surprising in these red rocks considering the conditions under which they were deposited. He speaks of an "alleged fault" at the Chit Rock, when the existence of the fault is "as plain as a pike-staff" (or was 15 years ago) to any unprejudiced observer. Of course, the sequence east of the Sid is not repeated at the Chit, because the beds have been destroyed by the erosion of the valley in which Sidmouth lies.

V.—The Upper Chalk of North Lincolnshire.

By Arthur Burnet.

In the Summer of 1902 I commenced an exploration of the chalk-pits on the eastern border of the Lincolnshire Wolds, starting at Louth and working northward. Mr. W. Hill had previously visited this locality, and had proved the existence of the zone of *Holaster planus* at Boswell, three miles north-west of Louth, and also at Kirmington, much farther north.[2] Mr. Jukes-Browne

[1] "The Red Rocks of the South Devon Coast," by Alexander Somervail (Transactions of Devonshire Association for the Advancement of Science, etc., vol. xxxv, pp. 617–630).

[2] W. Hill, "Note on the Upper Chalk of Lincolnshire": Geol. Mag., Dec. IV. Vol. IX (1902), p. 404.

suggested to me that I should try and obtain fossils from the intermediate pits, and thus extend the work commenced by Mr. Hill. As the result of visits to about thirty pits, ranging from near Louth to Barrow-on-Humber, I have obtained further evidence of the zone of *Holaster planus*, and also some indications of the zone of *Micraster cortestudinarium*.

I was unable to find any other sections showing beds which could be regarded as the exact equivalent of those seen at Boswell. These latter probably belong to the lowest part of the *Holaster planus* zone, and the palæontological evidence now available seems to show that the outcrop of the base of this zone lies further west than was originally supposed to be the case. In the quarry at Boswell (from which Mr. Hill obtained *Holaster planus*, *Micraster Leskei*, and *Ananchytes scutatus*) I found a good specimen of *Holaster placenta* and a *Micraster* (species doubtful).

The quarry at Acthorpe, a mile and a half north-west of Louth, is the most southerly point in Lincolnshire from which Upper Chalk fossils have been obtained. There I found the following:—*Inoceramus Cuvieri*, *Rhynchonella limbata*, *Rhynchonella Cuvieri*, and *Terebratula carnea*. *Infulaster eccentricus*, *Echinoconus globulus*, and *Rhynchonella limbata* had been previously found here by Mr. Rhodes, of the Geological Survey.

The beds exposed in the quarry three-quarters of a mile west-south-west of Fotherby are typical of those seen in most of the pits to be afterwards mentioned in this article. The section is as follows:—[1]

	ft.	in.
Broken white chalk	4	0
Layer of grey fuller's earth	0	3
Hard white chalk with flint nodules	6	0
Course of continuous flint	0	6
Hard creamy chalk without flints	8	6

Here I found several fossils, viz.:—

Serpula, sp. (small spiral).
Holaster planus.
,, *placenta*.
Goniaster (ossicle).
Cyphosoma (spine).
Terebratula carnea.
Terebratulina lata.
Kingena lima.
Rhynchonella Cuvieri.
Ostrea normaniana.
,, *vesicularis*.
,, sp.
Inoceramus Brongniarti?
Plicatula sigillina.
Septifer lineatus.

A pit near Fotherby Grange, and about three-quarters of a mile north of the above, yielded the following:—

Serpula, sp. (small spiral).
Terebratula carnea.
Terebratulina lata.
Rhynchonella Cuvieri.
Holaster planus?

A pit half a mile north-west of Lambcroft shows white chalk with flint bands of a peculiar nature, the flint being intermingled with lumps of white chalk. I found here *Rhynchonella Cuvieri*, *Kingena lima*, and a spine of *Cidaris perornata*.

[1] "Geology of part of East Lincolnshire," p. 69.

Similar beds also occur in the upper part of a pit a quarter of a mile south-west of North Ormsby. At the base of the pit, below the lowest band of imperfect flint, there is a bed of cream-white chalk, which yielded *Micraster Leskei*. Other fossils found in this pit were :—

Holaster, sp.
Magas pumilus.
Rhynchonella Cuvieri.
Terebratulina lata.
Ostrea vesicularis.
,, sp.
Inoceramus, sp.

It is not improbable that the upper beds of this pit, together with those seen at Lamberoft, belong to the zone of *Micraster cortestudinarium*.

A quarry half a mile east-south-east of North Ormsby yielded the following :—

Terebratula carnea.
Kingena lima.
Terebratulina lata.
Rhynchonella Cuvieri.
Inoceramus Cuvieri.
Holaster placenta.

Another quarry in the same village, to the north of the church, showed a similar section to that seen at Fotherby, with the following fossils :—

Terebratula carnea.
Rhynchonella Cuvieri.
Serpula, sp. (small spiral).
Ananchytes scutatus.
Inoceramus, sp.

The same lithological features were visible in a large quarry about half-way between North Ormsby and Wyham, from which I obtained *Rhynchonella Cuvieri*, *Kingena lima*, *Holaster planus* (or *placenta*), and a spine of *Cidaris*. I also found spines of *Cidaris sceptifera* in a small pit at Wyham.

There are two quarries at Cadeby, both of which show a course of the imperfect flint previously mentioned. The only fossil that I could find was *Ostrea vesicularis* ; the lithological character of the beds, and their extremely unfossiliferous nature, suggest the possibility that they belong to the zone of *Micraster cortestudinarium*.

Further west, in a quarry at Wold Newton, I found *Magas pumilus*, *Rhynchonella Cuvieri*, *Holaster planus*, and *Inoceramus*, sp.

Few fossils could be found in the pits at Hawerby, Ravendale, and Hatcliffe. At Hawerby I found *Terebratula carnea*, *Ostrea vesicularis*, and *Inoceramus*, sp. From East Ravendale I obtained a broken echinoderm, which is possibly *Ananchytes scutatus*.

The quarry near Beelsby Church yielded *Terebratula carnea*, *Rhynchonella Cuvieri*, and a species of *Inoceramus*.

The quarry half a mile south-west of Irby Church shows a section of hard chalk with tabular flints, and scattered flint nodules. Here I found :—

Holaster planus (or *placenta*).
Terebratulina lata.
Rhynchonella Cuvieri.
Spondylus latus.
Inoceramus Cuvieri.

Continuous bands of dark flint are also seen in a pit to the south-east of Riby. The fossils found here were *Holaster planus*

(or *placenta*) and *Rhynchonella Cuvieri*. Judging from the easterly position of this quarry, and also that at Irby, it seems possible that they are in the zone of *Micraster cortestudinarium*.

The quarry a quarter of a mile west of Great Limber Church is of interest, as it yielded some rather striking specimens, viz.:—*Infulaster eccentricus*, *Parasmilia centralis*, *Rhynchonella octoplicata*, and *Rhynchonella Cuvieri*. The *Infulaster* is a fine well-marked specimen, and is the second which has been found in Lincolnshire, confirming the occurrence of the species at this low horizon.

In another pit about half a mile east-south-east of the same village I found *Spondylus latus*, *Terebratula carnea*, and *Ananchytes scutatus*.

From the quarry at Limber Parva I obtained *Holaster planus* (or *placenta*) and *Serpula*, sp. The section here is very much overgrown, and a better exposure of the same beds is to be found in the quarry half a mile south-east of Kirmington, where Mr. Hill obtained *Holaster planus*. I also found here a specimen of that echinoderm, together with *Inoceramus Cuvieri*, *Kingena lima*, and *Rhynchonella Cuvieri*.

In a quarry three-quarters of a mile south of Ulceby I found *Magas pumilus*, *Terebratula carnea*, *Rhynchonella Cuvieri* (or *reedensis*), and *Ostrea vesicularis*.

The quarry a mile west of Ulceby shows soft white chalk with flint nodules and several layers of imperfect flint similar to those seen at Lambcroft and Cadeby. The fossils obtainable here have consequently a special interest, and those I found were:—

Micraster cortestudinarium.
Holaster planus (or *placenta*).
Ostrea vesicularis.
Rhynchonella reedensis.
Terebratulina lata?
Rhynchonella Cuvieri.
Terebratula carnea.

It is probable that this pit and the tract of chalk which lies between Ulceby and Barrow is in the zone of *Micraster cortestudinarium*.

Similar beds with tabular flints are seen at Wootton, and also in a large quarry three-quarters of a mile west of Thornton, but the only fossils found were:—*Inoceramus Cuvieri*, *Rhynchonella Cuvieri*, *Rhynchonella reedensis*? and *Terebratulina*, sp.

From a large quarry south of Barrow I obtained a number of fossils as follows:—

Terebratulina lata.
Terebratula, sp.
Magas, sp.
Kingena lima.
Rhynchonella Cuvieri.
Rhynchonella reedensis.
Holaster placenta.
Echinocorys (*Ananchytes*) *scutatus*.
Inoceramus, sp.

Although the exact correlation of these beds with the chalk zones in other parts of England is necessarily a matter of some difficulty, Mr. Jukes-Browne considers that the palæontological evidence which I have obtained establishes the existence of the zones of *Holaster planus* and *Micraster cortestudinarium* in North Lincolnshire. The extreme rarity of fossils, and the fact that we have to deal with isolated exposures separated from each other by a distance of a mile

or two, renders it an extremely difficult task to fix the dividing lines between the two zones and between the Middle and Upper Chalk. Further research in this district will no doubt throw additional light upon this subject and help to solve some of the still doubtful problems respecting the Lincolnshire Chalk.

All the fossils referred to in this article have been examined and named by Mr. Jukes-Browne, to whom I am in many ways greatly indebted for advice and assistance.

CLASSIFIED LIST OF FOSSILS.

LAMELLIBRANCHIATA.

Inoceramus Cuvieri, Sby.
,, *Brongniarti*, Sby.
,, (an unnamed species).
,, sp.
Spondylus latus, Sby.
Plicatula sigillina, Woodw.
Septifer lineatus, Goldf.
Ostrea vesicularis, Lam.
,, *normaniana*, d'Orb.
,, sp.

BRACHIOPODA.

Rhynchonella Cuvieri, d'Orb.
,, *limbata*, Schloth.
,, *recdensis*, Eth.
,, *octoplicata*, Sby.
Kingena lima, Defr.
Terebratula carnea, Sby.
Terebratulina lata, Eth.
Magas pumilus, Sby.

ECHINODERMATA.

Micraster Leskei, Desm.
,, *cortestudinarium*, Goldf.
,, sp.
Cyphosoma, sp.
Goniaster, sp.
Infulaster excentricus, Forbes.
Holaster planus, Mant.
,, *placenta*, Ag.
Ananchytes scutatus, Leske.
Cidaris sceptifera, Mant.
,, *perornata*, Forbes.
,, sp.

ANNELIDA.

Serpula, sp. (small spiral).

ACTINOZOA.

Parasmilia centralis, Mant.

REVIEWS.

I.—MEMOIRS OF THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM.

THE CRETACEOUS ROCKS OF BRITAIN. Vol. II: THE LOWER AND MIDDLE CHALK OF ENGLAND. By A. J. JUKES-BROWNE, with contributions by WILLIAM HILL. 8vo; pp. xiii, 568, map, 8 plates, illustrated. (London, 1903. Price 10*s*.)

THE first volume of this series of memoirs on the Cretaceous Rocks was reviewed at considerable length in the GEOLOGICAL MAGAZINE for February, 1901. In that review some idea of the plan of the work was given, and it will now only be necessary to sketch the contents of the present volume, which brings the subject-matter up to the zone of *Terebratulina gracilis* in the White Chalk.

The volume opens with a general account of the Chalk as a whole and a history of its subdivision into parts; an account of considerable

historical interest and valuable as defining the position taken by the authors in dealing with their subject.

Defining next the 'Lower' Chalk, the authors point out that this is divided into two zones, that of *Ammonites varians* and that of *Holaster subglobosus*. They also include in the latter the *Actinocamax plenus* marls, which "do not constitute a zone, and have no distinct zonal fauna," and they follow with a description and lists of the fossils which are characteristic of the beds.

Chapter iii deals with the 'Lower' Chalk of the Kentish coast, the classical section of which is to be found between Folkestone and Dover, and was the subject of the especial study of Mr. Hilton Price, who divided the two zones up into nine beds. Some slight modifications of Mr. Price's work is suggested; beds 3 and 4 are united, but the rest seem to have stood the test of recent research. Leaving the coast, a general description of these beds in the inland parts of Kent and Surrey is given, and Hampshire and Sussex are similarly treated, attention being called to the section between Beachy Head and Eastbourne, the beds in which are, however, too much disturbed to allow of a definite section being given.

Chapter vii introduces us to the Isle of Wight, and includes several important observations both as to the sections and the fossils, made since the second edition by Strahan and Reid of the memoir on that island, which was published in 1889. It is pointed out that the use of the words "Chloritic Marl" is continued because it is convenient and has been so long in use, but at the same time the green grains are not chlorite and the matrix is not a marl.

Chapters viii–xix deal in similar manner with the counties of Dorset, Somerset, Devon, Wilts, Berks, Oxford, Bucks, Beds, Herts, Cambridge, Suffolk, Norfolk, Lincolnshire, and Yorkshire; and Chapters xx and xxi provide a useful sketch of the beds of similar age in the north-east and north-west of France.

The Middle Chalk (the lowest beds of the White Chalk) is defined as consisting of the zones of *Rhynchonella Cuvieri* and of *Terebratulina*. This latter zone has long been known as the zone of *Terebratulina gracilis*, but Dr. Kitchin is quoted as pointing out that the true *gracilis* is confined to the higher beds of the White Chalk, and that the form so common in the *Terebratulina* zone seems to be that called *T. gracilis*, var. *lata*, of Etheridge. The 'Middle' Chalk is then described in similar detail to the 'Lower' Chalk, the authors proceeding county by county and tabulating a vast amount of valuable material in the several chapters. We see here for the first time the influence of the careful zoological work done in recent years by Dr. Rowe, of Margate, whose collecting has more definitely proved the boundaries of the several zones of the White Chalk. The 'Middle' Chalk portion of the memoir closes with a chapter on the French equivalents, allowing a comparison to be made at once useful and convenient.

Chapters xxii, xxiii and xlii, xliii are written by Mr. Hill, and treat of the microscopical structure of the rocks described in the memoir. Mr. Hill describes the macroscopic aspect of the rocks and

the microscopic aspect of thin sections, giving photomicrographs on pls. iv–viii. He describes the examination of the residues after washing, lists the minerals found, and tabulates the results. He gives a summary of the chemical analyses, and lists the Foraminifera, the species of which were determined by Mr. Chapman. The amount of valuable information thus brought together enables the authors to discuss the "Evidence of current action at the base of the Chalk," "Limits of the Chalk Sea," "Sedimentation," and the "Depth of Water" beneath which the several zones were accumulated. This last consideration is naturally a difficult problem, and no definite statement is possible. But the general considerations drawn from recent sources and the internal evidence available for observation "make it probable that the Chalk marl of the south-eastern and south-central counties was formed at a depth approaching, but probably rather less than 400 fathoms." Quoting Dr. Hume's conclusions, the authors continue—"it would seem that in passing upwards from the Chalk marl to the beds of nearly white chalk which underlie the Belemnite Marls, we are tracing the effects of a subsidence which carried the area through the bathymetrical limit of 400 fathoms, and that the zone of *Holaster subglobosus* was formed in water which finally approximated to a depth of 500 fathoms." Passing on to the lower beds of the White Chalk, the authors admit that the difficulties are greater. "No inference as to depth can be drawn from consideration of the mineral particles," beyond that "it [the 'Middle' Chalk] was formed in clear water of some depth at a considerable distance from land and in a region where there were no volcanoes." The evidence of the animal life seems to be conflicting, according to our present-day knowledge, and "it is very probable that during part of the Middle Chalk time the depth exceeded 500 fathoms; but . . . . there seems to have been a recovery by upheaval during the formation of the Chalk rock (zone of *Holaster planus*), consequently the time of greatest depth was probably that when the lower part of the *Terebratulina* zone was being accumulated."

II.—Grundzüge der Palæontologie (Palæozoologie), von Karl A. von Zittel, Professor an der Universität zu München. Abtheilung I: Invertebrata. Zweite verbesserte und vermehrte Auflage. Mit 1405 in den Text gedruckten Abbildungen. München und Berlin, Oldenbourg, 1903.

Textbook of Palæontology (Palæozoology). By K. A. von Zittel, Professor at the University of Munich. Part I: Invertebrata. Second edition, revised and enlarged, with 1405 figures printed in the text. 8vo; pp. viii, 558. (Price 16*s.* 6*d.*)

THAT a second edition of a work so valuable to all students of Palæontology as the "Grundzüge" of the late Professor von Zittel should be called for, after the lapse of nine years since the issue of the original, is not a matter of surprise. It is greatly to be lamented that the author should have been snatched away by his fatal malady whilst the revision was in progress, so that he was

only able to complete the first part, relating to the Invertebrate fossil fauna, and see it through the press. On account of the increased amount of subject-matter this new edition is to be brought out in two volumes, the first of which is now before us; it is furnished with an index so as to be complete in itself.

It is well known that about four years ago an English translation of the "Grundzüge" appeared under the title of "Textbook of Palæontology." It was edited by Dr. C. R. Eastman, of Harvard University, a former student of von Zittel, assisted by several collaborators, who were, with two exceptions, American authorities of special eminence in their respective subjects. By these authors most of the fossil groups in the "Grundzüge" were revised to such an extent that the system of classification in the new Textbook could not rightly be claimed as the same as that in the "Grundzüge." And that it was so regarded by American palæontologists is shown in a published review of it, by one of their number, from which the following is an extract:—

"Palæontological science is certainly beholden to Wachsmuth, Sladen, Ulrich, Schuchert, Dall, and others for their labours of love in trying to make this an authoritative and trustworthy textbook. How well they have succeeded remains to be determined after the book has been used in the laboratory. The improvement is so marked over the German edition, the 'translation' contains so little from the original, and the 'revision' is so complete, that the question naturally arises whether Dr. Eastman could not just as well have gone a little further in his work and made it a textbook by American authors, which would have held the same place among English-speaking people as the original Handbuch does among Europeans."[1]

That Professor von Zittel did not agree with the extensive and important alterations introduced in the translation (so-called) of his "Grundzüge" is shown in his preface (in German) to the Textbook, in which he points out some of the difficulties and discrepancies resulting from the collaboration of a number of specialists whose views on systematic classification agreed neither with his own nor with each other. As a specially unfortunate instance he quotes the fact that in the Textbook the Chætetidæ and Fistuliporidæ are in one part treated as belonging to Corals and in another referred to the Bryozoa! In this new edition, moreover, von Zittel rejects most of the alterations made in the Textbook, and holds fast to the classification of the first edition of the "Grundzüge," which is more in accord with the views of German palæontologists than with those of America.

Without pretending to any detailed criticism, a few remarks may be made on the contents of this volume. And, first, it is noticeable that no addition or alteration appears to have been made in the description and distribution of Foraminifera, Radiolaria, and Porifera, which remain the same as in 1895, though we should have looked for some reference to the fresh discoveries of Radiolaria in the

[1] Journal of Geology, Chicago, vol. iv, 1896, p. 738.

Palæozoic rocks of this country and other regions in the interval; and no mention is made of the occurrence of fossil representatives of the Lithonine Calcisponges.

In the chapter on the Corals a valuable addition has been made by the very clear description of the microscopic structure of their skeleton, accompanied by excellent figures, which has been contributed by Mrs. Dr. Ogilvie Gordon. Von Zittel still retains the Tetracoralla or Rugosa as a distinct order of the Madreporaria sclerodermata, on the ground of its possessing a combination of characters, including that of the feather-like arrangement of the septa, which never occur in the Hexacoralla. The classification of the Hexacoralla follows the system of Dr. Ogilvie Gordon, and the Aporosa and Perforata are not continued as independent groups.

The families of the Favositidæ, Chætetidæ, and Monticuliporidæ are placed, with some others, near the Alcyonaria, but their systematic position is considered doubtful. The Monticuliporidæ and its allies are treated very briefly, in strong contrast to the elaborate description of the group by Ulrich in the Textbook, where they are referred by him to the Bryozoa, and the evidence strongly supports this view of their position.

The recent work of Bather and of Jaekel on the Cystoidea has necessitated a rearrangement of this division, which is now placed in the orders of Thecoidæ, Jaekel, Carpoidæ, Jaekel, and Hydrophoridæ, Zittel.

The classification of the Brachiopoda in the first edition of the "Grundzüge" was based on that of Thomas Davidson, and it is continued substantially the same in the present one, though, of course, due mention is made of the systems of Beecher and of Schuchert, which depend mainly on the embryological features of these organisms.

Also with respect to the Cephalopoda, in the description of which the author was assisted by his friend Dr. Pompeckj, the classification of 1895 is retained with some needful modifications, and that of the late Professor Hyatt in the Textbook is passed over, the author remarking that it might be considered as an original treatise, much of which related to facts which had not previously been published.

In conclusion, we venture to think that apart from its own merits this volume will be highly valued by palæontologists as the final work of a great master of the science, who spared no efforts in his devotion to it, and died, as he had lived, in its service.

III.—The Fossil Plants of the Carboniferous Rocks of Canonbie, Dumfriesshire, and of Parts of Cumberland and Northumberland. By R. Kidston. Trans. Roy. Soc. Edinburgh, vol. xl, pt. 4 (No. 31), pp. 741–833, with 5 plates.

In the February number of the Geological Magazine (p. 82) a notice appeared of a memoir by Messrs. Peach and Horne on the geological structure of the Canonbie Coalfield of the Scottish borderland. The present paper by Mr. Kidston forms an important

contribution to the fossil flora of the same district. The succession of Carboniferous rocks, both Upper and Lower, is here very perfect, ranging from the Calciferous Sandstone to the Upper Coal-measures. The presence of true Upper Coal-measures in this coalfield, with its characteristic flora, is especially remarkable. This horizon has previously only been found in Britain in the three Southern coalfields of South Wales, Somerset, and the Forest of Dean.

Mr. Kidston's paper also contains the most important contribution to the Lower Carboniferous flora of Britain which has so far been published. A large number of species are described from the Calciferous Sandstone series, or its geological equivalents, of Dumfries, Cumberland, and Northumberland. Figures of several of these plants are given, in addition to new species of *Sigillaria*, *Stigmaria*, *Pinakodendron*, and *Palæostachya*, and a new genus *Eskdalia* from various horizons.

IV.—An Attempt to Classify Palæozoic Batrachian Footprints. By Dr. G. F. Matthew. Trans. Roy. Soc. Canada, ser. II, vol. ix, sec. iv, p. 109.

New Genera of Batrachian Footprints of the Carboniferous System in Eastern Canada. By G. F. Matthew, LL.D. Canada Rec. Sci., vol. ix, No. 2, p. 99, 1903.

THESE two articles are complementary. The first is a survey of the described Carboniferous and Devonian footprints of America, with an attempt to classify them under generic heads. It was found that diverse genera had been described under one generic name, and that closely related tracks had been described under different generic names by various authors. A table is given to exemplify this; in the table the genera are divided into related groups, based on the number of toe-marks and the general aspect of the footprint. The principal authors who have described these tracks are King, Leidy, Lea, Butt, Marsh, and Dawson. The chief places where these footprints have been found are the coalfields of Eastern Pennsylvania, of Kansas, and of Nova Scotia. Some of the types are common to several of these regions.

In his second article Dr. Matthew gives figures and descriptions of a number of new genera of Batrachian footprints from the Lower Carboniferous and the Coal-measures of Nova Scotia. The smaller forms are from the Joggins Coalfield, a larger one from the coalfield of Sydney, Cape Breton, and another large one from the Lower Carboniferous of Parrsboro', N.S. The figures show great diversity of type, and justify the reference to different genera.

The material described is mostly in the Redpath Museum of McGill University, Montreal, and is a part of the large collections made by the late Sir J. W. Dawson. Three plates of figures accompany the first article and one the second.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—February 19th, 1904.—Sir Archibald Geikie, Sc.D., D.C.L., Sec. R.S., Vice-President, in the Chair.

Annual General Meeting.

The Chairman read the following letter which had been addressed to him by the President :—

February 9th, 1904.

"Dear Sir Archibald,

"Please kindly convey to the Council, the Officers, and the Fellows of the Geological Society my sincere regrets that I am not yet well enough to attend the Anniversary Meeting, and personally thank them for the honour they paid me in making me their President, and for their unfailing goodness to me during my tenure of office.

"I shall also be grateful if you will congratulate on my behalf the new President and the recipients of Medals and Awards; and assure the Fellows of my constant sympathy with, and faith in, the continued progress of the Society, and of my hope to be soon once more amongst them as a fellow-worker.

"Thanking Mr. Teall and yourself for your great kindness in taking over my Presidential work for me during my illness, and so relieving me of all responsibility,

"I remain, dear Sir Archibald,

Sincerely yours,

"Sir Archibald Geikie, D.C.L., Sec.R.S." Charles Lapworth.

A telegram expressing the Society's sympathy with Professor Lapworth and good wishes for his prompt convalescence was, with the approval of all the Fellows present, despatched to him.

The Reports of the Council and of the Library and Museum Committee for the year 1903, proofs of which had been previously distributed to the Fellows, were then read.

The reports having been received and adopted, the Chairman handed the Wollaston Medal, awarded to Professor Albert Heim, of Zürich, to Mr. J. J. H. Teall, M.A., F.R.S., for transmission to the recipient, addressing him as follows :—Mr. Teall,—

The Council of the Geological Society of London have awarded to Professor Heim the highest honour which they have to bestow, the Wollaston Medal, in recognition of the value of his researches concerning the mineral structure of the Earth, and more especially of his contributions towards the elucidation of the structure of mountain-masses, as illustrated in the chain of the Alps. In his great monograph, the "Mechanismus der Gebirgsbildung," he traced with remarkable skill the influence of plication in the terrestrial crust, following this influence step by step from the distortion and fracture of organic remains in hand-specimens up to the most gigantic foldings which have comprised a vast mountain-chain in their embrace. His researches, however, have not been confined to the internal structure of the Alps. He has devoted himself with not less enthusiasm and success to the study of their glaciers and their landslips. Gifted with no ordinary artistic power, he has been able to enrich geological science with a valuable series of landscape drawings and sections, in which the intimate relations of geology and topography are admirably delineated. His latest achievement in this department is a large model of the massif of the Hohe Säntis, which was exhibited at the recent meeting of the International Geological Congress in Vienna. It was admitted by the assembled geologists to be probably the most accurate and beautiful model of a mountain-group that had ever been constructed. We may judge of the labour and enthusiasm spent on it from the fact that, besides climbing to every crest of that rugged tract, Prof. Heim made many ascents in a balloon, so as to obtain detailed and comprehensive bird's-eye views of the whole region which he wished to depict. In asking you to be so good as to transmit to him this Medal, I would request you to convey with it an expression

of our warmest wishes for a long continuance of the mental and bodily activity which he has so unsparingly devoted to the interests of our science.

Mr. Teall, in reply, read the following translation of a letter which had been forwarded by the recipient:—

"I much regret that my duties here make it impossible for me to be present at your annual meeting, and that I am therefore unable in person to express my thanks for the honour which you are conferring upon me.

"It may perhaps interest you to know the circumstances which led me to turn my attention to geology. When, at the age of nine years, I visited the Alps for the first time, in company with my father, the mountains appealed to my youthful imagination, and I then conceived the idea of representing them not only on paper but also in relief. I accordingly attempted to model them in clay, working at first directly from nature, and afterwards by the aid of the topographic maps which were then appearing. I soon found that one can only represent correctly that which one understands, and I was thus led to study the internal structure as well as the external form of the mountains.

"At the age of sixteen years I had prepared a model of the Tödi group on a scale of 1 : 25,000. Arnold Escher von der Linth heard of this model, and came to see it at my own home. This was the first time that I saw that illustrious man. He invited me to accompany him on a geological excursion, and from that time onward I looked up to him as my revered master. Thus the pleasure which I derived from my early visits to the mountains and my desire to represent them in relief led me naturally to the study of geology.

"In receiving this high honour at your hands, I remember with heartfelt gratitude the instruction and encouragement that I have derived from a study of the literature and geology, and especially from personal intercourse with the fellow-workers, of the great nations which lie beyond my own small fatherland. Among these I reckon the British Empire as especially deserving of my gratitude. More than 35 years ago I derived inspiration as a student from a study of the works of Sir Charles Lyell, and since that time have continued to hold intercourse with British geologists—many of them Fellows of your Society—and to study their writings and collections.

"I am conscious that my work is very imperfect, and that in it error is mixed with truth. My life is unfortunately so overburdened with official and private duties that I have but little time for original research; yet I am filled with an earnest desire to do more, for I recognise that in such research is to be found the greatest happiness that human life can afford.

"It seems to me that the work which I have accomplished does not entitle me to this honour. I prefer rather to regard it as the recognition of a sincere effort to extend our knowledge, and I can assure you that, so far as in me lies, the remainder of my life shall be devoted to this object. You have given me a fresh stimulus—a new encouragement. I thank you from the bottom of my heart."

The Chairman then presented the Murchison Medal to Professor George Alexander Lebour, M.A., M.Sc., addressing him in the following words:—Professor Lebour,—

The Council have this year awarded to you the Murchison Medal, in recognition of the importance of your contributions to our knowledge of the Carboniferous and other rocks of the North of England. For thirty years you have been engaged in these researches, which have resulted in more accurate determinations of the stratigraphy of the Carboniferous System of Northumberland, and more satisfactory correlations of the various divisions of that system throughout the northern counties. In conjunction with Mr. Topley you brought forward convincing evidence that the famous Whin Sill is an intrusive sheet, and not, as some observers had supposed, an intercalated lava. Your papers on the salt-measures and on the Marl Slate and Yellow Sands of your district have likewise added to our knowledge of these formations. This original work, however, has for many years been carried on in the intervals of a life primarily devoted to the teaching of geology, and we wish to mark our sense of the value of your educational labours as a Professor in the University of Durham. As one who in former days served under Murchison, you will doubtless value this medal as another link connecting you with that great

master of our science. I may perhaps be permitted to add an expression of my own gratification that, looking back on my early association with you as a colleague in the Geological Survey, it has fallen to me to hand you to-day this mark of appreciation from the Council of the Geological Society.

Professor Lebour replied as follows:—Sir Archibald Geikie,—

My feelings on this occasion are divided between regret at the absence of my old friend Professor Lapworth and gratification at receiving the Medal which commemorates my first chief, Sir Roderick Murchison, from the hand of one who was his favourite colleague, his successor, and his biographer. An award such as this is of the greatest value to a teacher: it confirms his pupils in the trust which they place in him, and at the same time gives him confidence in carrying on his own work. In my case, I will not be so presumptuous as to question the propriety of the Council's decision, however it may have surprised me. I am especially pleased that in the too kind words that you have uttered, the name of my dear friend and colleague of long ago, William Topley, has once more been coupled with mine. I am sure that no one would have rejoiced more than he at my good fortune this day. I beg most heartily to thank the Council for the honour which they have done me.

In handing the Lyell Medal, awarded to Professor Alfred Gabriel Nathorst, of Stockholm, to Baron C. de Bildt, Envoy Extraordinary and Minister Plenipotentiary of H.M. the King of Sweden and Norway, for transmission to the recipient, the Chairman addressed him as follows:—Baron de Bildt,—

Your Excellency has been good enough to come here to-day to receive for your countryman, Professor Nathorst, of Stockholm, the Lyell Medal, which has been awarded to him this year by the Geological Society in recognition of his long and distinguished labours to advance our knowledge of the vegetation which at successive periods in the history of the earth has flourished in Northern Europe and the Arctic regions. These labours range from the oldest to the youngest ages of geological time. Among the most ancient rocks various curious markings, which had generally been regarded as traces of marine plants, were shown many years ago by Professor Nathorst, after an ingenious series of experiments, to be probably not of vegetable origin. But while he thus cut off what had been supposed to be an early marine flora, he has greatly extended our acquaintance with the terrestrial floras of Palæozoic time in the Arctic regions. His papers on the extension of the vegetation of the Upper Old Red Sandstone as far north as Bear Island, continuing the earlier work of Heer, are of special interest. He has thrown much light on the flora of the Triassic deposits that extend into the south of Sweden. From the far northern King Charles Land he has made known the existence of a Jurassic and a Cretaceous flora. His researches among Pleistocene and recent deposits, and the history which he has thence deduced of plant-migration and changes of climate in Europe, are singularly interesting and suggestive. Though it is as a student of fossil plants that Professor Nathorst is most widely known, it was his keen eyes that detected for the first time casts of medusæ in the Lower Cambrian rocks of Scandinavia. In transmitting to him our Lyell Medal, your Excellency will, I hope, accompany it with an expression of our best wishes for his health and the long continuance of his scientific energy.

Baron de Bildt, in reply, read the following letter which he had received from Professor Nathorst:—

"Allow me to express my heartiest thanks to the Council for the great and quite unexpected honour which they have conferred upon me by the award of the Lyell Medal. I regard this mark of approval of my geological and palæontological labours as a most gratifying distinction, and it encourages me to hope that, as the end of my life approaches, I may have the satisfaction of feeling that I have not lived altogether in vain.

"My gratification at receiving this honour is increased by the fact that it is associated with the name of Sir Charles Lyell. I vividly remember the enthusiasm with which, as a mere youth, I read the Swedish edition of his admirable and fascinating 'Principles of Geology': and it is only right to add that it was this

work which first excited my love for geology: a branch of science which the Geological Society of London has vigorously promoted for almost a century.

"During my first visit to England in 1872, at the age of 21, I was fortunate enough to be introduced to the great English geologist; and I still cherish a vivid remembrance of his kind and noble personality, and of his keen interest in my then recent discovery of the remains of *Salix polaris* and other Arctic plants in the Glacial deposits of the Norfolk coast. The meeting with Sir Charles forms one of the most highly prized reminiscences of my youth.

"Let me also express my great satisfaction at receiving this Medal through so illustrious a geologist as Sir Archibald Geikie, whose writings have served as a source of information to the majority of geologists throughout the world."

The Chairman then handed the Balance of the Proceeds of the Wollaston Donation Fund, awarded to Miss Ethel Mary Reader Wood, M.Sc., to Dr. J. E. Marr, F.R.S., for transmission to the recipient, and addressed him in the following words:—Dr. Marr,—

The Council have awarded to Miss Wood the Balance of the Proceeds of the Wollaston Donation Fund as an acknowledgment of the value of her contributions to our knowledge of the Graptolites and of the rocks in which these organisms occur. Her papers furnish an excellent example of the application of zonal stratigraphy to groups of rocks which were thought to be already known with tolerable completeness. Much still remains to be done in this department of investigation. We had looked forward with pleasure to seeing her among us here to-day, but she has been unavoidably prevented from coming to London. In sending the award to her, you will be so good as to express to her our hope that she will regard it as a token of the interest which we take in her work, and as an encouragement to her to continue to devote herself to the cause of science with the same skill and enthusiasm which have hitherto so eminently distinguished her career.

In presenting the Balance of the Proceeds of the Murchison Geological Fund to Dr. Arthur Hutchinson, M.A., F.C.S., the Chairman addressed him as follows:—Dr. Hutchinson,—

The Balance of the Proceeds of the Murchison Geological Fund has this year been awarded to you, in acknowledgment of the ability which the Council recognise in your published memoirs on mineralogical subjects, and to encourage you in further work. We especially desire to recognise the skill and industry displayed by you in two important memoirs. Your paper on the Diathermancy of Antimonite introduced and successfully applied a new method of crystallographic investigation, wherein an opaque mineral is examined between crossed nicols, by means of transmitted heat-rays, corresponding to the usual optical examination of transparent minerals. Your memoir on Stokesite records the discovery of a new mineral, of which you found only a single crystal upon a specimen of Cornish axinite. Your analysis proved it to be a compound of most unusual type—a silicate containing tin.

The Chairman then presented a moiety of the Balance of the Proceeds of the Lyell Geological Fund to Professor Sidney Hugh Reynolds, M.A., addressing him in the following words:—Professor Reynolds,—

This award is made to you in special recognition of the value of your contributions to our knowledge of the Palæozoic rocks of Ireland and of the geology of the Bristol district, and to encourage you in further work. During the past eight years the Society has received from you a series of important papers which have appeared in its Quarterly Journal. In association with Mr. Lake you presented some interesting facts in regard to the *Lingula*-Flags of the Dolgelly district. In conjunction with Mr. Gardiner you have carried out a series of researches among the Silurian rocks of the South-East and of the West of Ireland, and have thrown fresh light on their associated volcanic rocks. Together with Professor Lloyd Morgan, you have worked out the geology of the Tortworth district, and have cleared up the interesting history of its volcanic eruptions; while you have more recently studied the Carboniferous volcanic rocks of the neighbourhood of Weston-super-Mare. In addition to all these geological undertakings, you are still further

widening the range of your studies by continuing the Palæontographical Society's memoir on the Pleistocene Mammalia. We cordially hope that many long years of active scientific work are in store for you, and that you will continue to enrich our Quarterly Journal with the results of your researches.

In handing the other moiety of the Balance of the Proceeds of the Lyell Geological Fund, awarded to Dr. Charles Alfred Matley, to Professor W. W. Watts, M.A., M.Sc., Sec. G.S., for transmission to the recipient, the Chairman addressed him as follows:—Professor Watts,—

The other moiety of the Lyell fund has by the Council been assigned to Dr. Matley, as an acknowledgment of the value of his work in elucidating the geology of Anglesey, and to encourage him in further work. The complicated structure of that part of North Wales has long been recognised, but the nature and extent of the complication have only been realised in recent years, since more enlarged and accurate views of geological tectonics have been reached. It would be rash to assert that all the difficulties have been cleared away, but Dr. Matley has made a notable forward step in removing them. Besides his work in Anglesey, he has devoted time and thought to the Cambrian formations of Pembrokeshire, and to the Keuper Marls and Sandstones of Warwickshire. We wish him many years of health and continued geological industry.

The Chairman then handed the Proceeds of the Barlow-Jameson Fund, awarded to Mr. Hugh John Llewellyn Beadnell, to Major C. E. Beadnell, late R.A., for transmission to the recipient, addressing him in the following words:—Major Beadnell,—

The Barlow-Jameson fund is awarded to your son, Mr. Hugh John Llewellyn Beadnell, in recognition of the value of his memoirs on the topography of the Oases and other districts of the Libyan Desert, and for his important collections of vertebrate fossils made in Egypt during the last three years. The enthusiasm with which he has prosecuted his researches in the Geological Survey of Egypt led some time ago to an attack of fever which nearly proved fatal. We hope that he will be able henceforth to ward off all such attacks, and to continue the career which he has so successfully begun. In transmitting to him this award of the Council, you will not fail to convey to him an expression of our interest in his researches, and of our hope that he will be encouraged to continue to pursue them.

The Chairman then proceeded to read the Anniversary Address that he had prepared, giving first of all obituary notices of several Fellows deceased since the last annual meeting, including Mr. W. T. Aveline (elected a Fellow in 1848), Mr. R. Etheridge (el. 1854), Sir Charles Nicholson (el. 1841), Mr. W. Vicary (el. 1864), Dr. W. Francis (el. 1859), the Rev. H. Maxwell Close (el. 1874), and Dr. H. Exton (el. 1883); also of Professor J. P. Lesley (el. For. Memb. 1887), Geheimrath K. A. von Zittel (el. For. Memb. 1889), Professor A. F. Renard (el. For. Memb. 1884), and Herr Felix Karrer (el. For. Corresp. 1890).

He then dealt with the bearing of the evidence furnished by the British Isles as to the problem whether in the so-called secular elevation and subsidence of land it is the land or the sea which moves. The first section dealt with the proofs of emergence of land as displayed in raised beaches or strand-lines. Objection was taken to the explanation given by Professor Suess of the strand-lines of the Norwegian fjords, which, the author maintained, do not mark the levels of ancient ice-dammed lakes, but former margins of the sea. A comparison was made of these strand-lines with the raised

beaches of Britain, and it was contended that the Seter or rock-shelves of Norway, which were claimed as the results of weathering caused by diurnal variations of temperature, could be paralleled in the rock-shelves of undoubtedly marine origin round both sides of Scotland. The second section of the address was devoted to the proofs of submergence furnished by fjords and sunk forests. It was shown that in the South of England and Wales a remarkable oscillation had taken place, the raised beaches being first brought much higher than their present level above the sea, and standing at that higher level when the lowest sunk forests existed as land-surfaces; while, by a subsequent submergence, these forests were placed under low-water mark and the raised beaches were brought into their present relations to the sea-level. The third section briefly pointed out the inferences to which the facts seemed most naturally to point. It was argued that the variations in the development and height of the raised beaches could not be satisfactorily explained by any conceivable variation in the level of the sea; while, on the other hand, the proofs of submergence in the south of our island in Neolithic time and of emergence in the north, were only intelligible on the supposition of unequal movement of the land. The conclusion thus reached was in favour of the generally accepted view that changes of level, such as those of Pleistocene and Post-Pleistocene time, in the British area, have been primarily due, not to any oscillation of the surface of the ocean, but directly to movements of the terrestrial crust.

The ballot for the Council and Officers was taken, and the following were declared duly elected for the ensuing year:—*Council:* The Right Hon. Lord Avebury, P.C., D.C.L., LL.D., F.R.S., F.L.S.; F. A. Bather, M.A., D.Sc.; W. T. Blanford, C.I.E., LL.D., F.R.S.; Professor T. G. Bonney, Sc.D., LL.D., F.R.S., F.S.A.; Sir John Evans, K.C.B., D.C.L., LL.D., F.R.S.; Professor E. J. Garwood, M.A.; Sir Archibald Geikie, Sc.D., D.C.L., LL.D., Sec.R.S.; Professor T. T. Groom, M.A., D.Sc.; Alfred Harker, Esq., M.A., F.R.S.; R. S. Herries, Esq., M.A.; Professor J. W. Judd, C.B., LL.D., F.R.S.; Percy F. Kendall, Esq.; Philip Lake, Esq., M.A.; Professor Charles Lapworth, LL.D., F.R.S.; Bedford McNeill, Esq., Assoc. R.S.M.; J. E. Marr, Sc.D., F.R.S.; Professor H. A. Miers, M.A., F.R.S.; H. W. Monckton, Esq., F.L.S.; E. T. Newton, Esq., F.R.S.; G. T. Prior, Esq., M.A.; Professor W. W. Watts, M.A., M.Sc.; the Rev. H. H. Winwood, M.A.; and H. B. Woodward, Esq., F.R.S.

Officers:—President: J. E. Marr, Sc.D., F.R.S. *Vice-Presidents:* Professor T. G. Bonney, Sc.D., LL.D., F.R.S., F.S.A.; Sir Archibald Geikie, Sc.D., D.C.L., LL.D., Sec.R.S.; E. T. Newton, Esq., F.R.S.; and H. B. Woodward, Esq., F.R.S. *Secretaries:* R. S. Herries, Esq., M.A.; and Professor W. W. Watts, M.A., M.Sc. *Foreign Secretary:* Sir John Evans, K.C.B., D.C.L., LL.D., F.R.S., F.L.S. *Treasurer:* W. T. Blanford, C.I.E., LL.D., F.R.S.

II.—February 24th, 1904.—J. E. Marr, Sc.D., F.R.S., President, in the Chair.

The President read the following resolution of the Council, which had been forwarded to Mrs. McMahon:—

"That the Council desire to place on record their regret at the death of General C. A. McMahon, F.R.S., who for so many years was one of their colleagues, and took so active an interest in the affairs of the Society; and the Council further wish to express their sincere sympathy with Mrs. McMahon and the family in their bereavement."

The President also announced that Professor T. G. Bonney, Sc.D., F.R.S., and Mr. H. W. Monckton, F.L.S., would represent the Society at General McMahon's funeral on the following day.

The President stated that Professor Lapworth had written, thanking the Fellows for their kind expression of sympathy with him in his illness, and for the telegram despatched to him in the course of the annual general meeting.

The following communications were read :—

1. "Eocene and Later Formations surrounding the Dardanelles." By Lieut.-Col. Thomas English, late R.E., F.G.S.

Our present knowledge of the older rocks, upon which the Tertiary beds surrounding the Dardanelles rest, only suffices to indicate the positions of the outcrops of a succession of schists, crystalline limestones, granites, and serpentines, which can be traced from the Ægean district into the Marmora, where they formed an archipelago in the Eocene sea.

The Eocene deposits surrounding these old rocks commence with sandstones, conglomerates, and clays, which become calcareous and nummulitic upward, and are about 2,000 feet thick in the aggregate. They are succeeded by 3,000 feet of lacustrine sandstones, clays, and schists, interstratified with volcanic rocks, and containing coal-seams. These beds have yielded *Anthracotherium*, plant-remains, and *Corbicula semistriata* at the coal-horizon, which is near the middle of the series. They are widely spread in Southern Thrace, and are cut off to the eastward by the falling-in of the Marmora sea-bed. The author has traced them along the Gallipoli Peninsula to Imbros Island—Lemnos and Samothrake are partly composed of similar beds; and he considers that all these deposits represent the uppermost Eocene and the Oligocene, and that the coal-seams belong to the latter.

The folding of the Lower Tertiary strata is plainly marked, and prolongs the direction of the Greek 'flysch'-deposits into the Marmora, forming basins in which the Miocene beds accumulated.

There are three main folds, all passing east-north-eastward through the Eocene channel between the old rocks of Thrace and those of the Troad.

The central fold developed farther eastward in post-Sarmatic times, rising into a ridge at Dohan Aslan, which dammed the outlet for the Marmora water to the west, and was the proximate cause of the formation of the Bosphorus in the Pontic Period, and of the Dardanelles at the end of the Pliocene. Volcanic eruptions were prolonged from Cretaceous to Miocene times in Thrace, Imbros, Lemnos, and Mitylene. Strati Island is entirely volcanic, and the greater part of Imbros also.

Marine Miocene (Helvetian to Tortonian) deposits appear north of the Gulf of Xeros and in the Marmora, and are probably vestiges of a Lower Miocene sea connection between the Ponto-Caspian and the Mediterranean.

Sarmatic deposits, first fresh-water, then marine, result from the

development of a lake, with a narrow opening north-eastward to the Pontic area, which occupied a large portion of the district. The fresh-water beds are still nearly horizontal in the Dardanelles, but are much dislocated along the northern shore of the Sea of Marmora, where they contain naphtha and lignite. The overlying marine (*Mactra*) limestones fringe the fresh-water beds as a shore-belt for 30 miles along this coast, and extend through the Dardanelles to the Southern Troad.

Brackish and fresh-water Pontic strata occur in numerous detached lake-basins which drained north-eastward. The Bosphorus was probably cut by river action through the rim of the lowest of these basins, on the recession of the Sarmatic Sea, and the Ægean drainage then passed into the large, closed, brackish lake described by Andrussov as occupying the Black Sea area from the Pontic to the beginning of the Diluvial Period.

The water-line of this sea lake finally receded to nearly 200 feet below its present shore-line, when the Sea of Marmora stood about 80 feet higher. Then the water began to rise again during the Pliocene, the Sea of Marmora regained its former westerly extension to Gallipoli, and deposited the bed of Caspian shells on which that town is built.

The lacustrine beach at Hora, 130 feet above sea-level, commemorates the last high-water mark of the Ponto-Caspian closed basin. The Ægean land had meanwhile settled down, forming a large depressed area, probably bounded to the south by the chain of the Northern Cyclades, and the Sarmatic beds dipped westward, reversing the drainage of the country south-west from Gallipoli. When the watershed of a river occupying the Dardanelles Valley was worn down to the level of the Marmora, in early Pleistocene times, the channel was rapidly widened and deepened to its present section by the outflow of Pontic water. The Mediterranean also passed the barrier of the Cyclades during the Pleistocene Period, and when equilibrium was restored, the water in the Sea of Marmora stood somewhere near its present level. There have been various oscillations since, of which the positive changes of level are indicated by Pleistocene Mediterranean deposits at Samothrake up to 650 feet, and a raised beach at Hora at 400 feet, also by numerous shell banks and terraces up to 100 feet above the present sea-level. There is, moreover, abundant evidence of a rise to 1000 feet during or after the Glacial Period, by which a red stony clay, formed at the expense of the surface-soil of a land area, has been widely spread.

The paper is accompanied by three appendices, one on the rock-specimens, by Dr. J. S. Flett; one on the collection of Tertiary and Post-Tertiary fossils, by Mr. R. Bullen Newton; and a third, by Mr. R. Holland, on species of Nummulites.

2. "The Derby Earthquakes of March 24th and May 3rd, 1903." By Dr. Charles Davison, F.G.S.

The undoubted earthquakes of this series were four in number. The first and strongest occurred on March 24th, 1903, at 1.30 p.m.,

and was felt over an area of about 12,000 square miles, its centre coinciding with the village of Kniveton, near Ashbourne. The shock consisted of two distinct parts, separated by an interval of about three seconds, which coalesced, however, within a narrow rectilinear band running centrally across the disturbed area at right angles to the longer axes of the isoseismal lines. The isacoustic lines (or lines of equal sound-audibility) are very elongated curves, distorted along the rectilinear band. The earthquake, it is concluded, was caused by simultaneous slips within two detached foci situated along a fault-service running from north 33° east to south 33° west, hading to the north-west, and passing close to the village of Hognaston. The strongest after-shock occurred on May 3rd, its focus lying along the same fault, for the most part between the two foci of the principal earthquake, but much nearer the surface.

Observations of the principal earthquake were made in many of the mines near the epicentral district. The sound, in such cases, was a much more prominent feature than the shock; it appeared to travel through the overlying strata, and in one pit in which observations were made in four seams at different depths, it was more distinctly audible in the lower than in the shallower seams.

The principal earthquake was registered by an Omori horizontal pendulum at Birmingham, by a Milne seismograph at Bidston (near Birkenhead), and by a Weichert pendulum at Göttingen (502 miles from the epicentre). The larger waves travelled with a velocity of 2·9 kilometres per second.

III.—March 9th, 1904.—J. E. Marr, Sc.D., F.R.S., President, in the Chair. The following communications were read:—

1. "On the probable Occurrence of an Eocene Outlier off the Cornish Coast." By Clement Reid, Esq., F.R.S., F.L.S., F.G.S.[1]

An extensive deposit of subangular Chalk flints occurs near Marazion, opposite a deep and wide valley which connects St. Ives Bay and Mount's Bay. This valley, though containing at St. Erth Lower Pliocene beds, is shown to be of much earlier date, and is probably an Eocene river-valley. Eocene rivers seem to have radiated from Dartmoor westward as well as eastward. The flint-and-chert gravel corresponds closely with the Eocene gravel of Haldon, and is apparently derived from a deposit under the sea off St. Michael's Mount. Continuing the direction of the Eocene valley seaward, the isolated mass of phonolite of the Wolf Rock is met with. The evidence suggests that, underlying the western part of the English Channel, an Eocene basin may occur comparable in importance with that of Hampshire.

2. "The Valley of the Teign." By Alfred John Jukes-Browne, Esq., B.A., F.G.S.

The Teign Valley is one of the most remarkable in the British Islands, because it is not a transverse valley preserving a general direction in spite of opposing ridges, nor is it a longitudinal valley

[1] Communicated by permission of the Director of H.M. Geological Survey.

running parallel to a dominant ridge, nor is it a simple combination of one with the other, as often happens; but it apparently consists of parts of two transverse valleys linked by a longitudinal one.

The Teign runs off Dartmoor through a gorge which takes an easterly direction, as if it were going to join the Exe; it is then deflected southward into what, with respect to the Permian escarpment, is a longitudinal valley; this ends in a low-lying plain, and from this plain it escapes eastward to the sea through a transverse valley, which has been cut across the ridge of Permian and Cretaceous rocks.

Several attempts have been made to explain the anomalies of the course taken by the Teign; but none of them is satisfactory, because the writers have not sufficiently considered the probable conditions of the surface on which the river-valleys were originated, or the extent to which the older rocks around Dartmoor may have been covered by Cretaceous and Tertiary deposits.

The author considers these points, and concludes that in Oligocene time a thick mantle of soft Neozoic strata must have stretched across Devon and the adjacent parts of the English Channel; that this mantle consisted mainly of Selbornian Sands and of the later Eocene deposits, the latter overlapping the former and passing on to the surface of the Palæozoic rocks; further, that these Eocene deposits covered all the central parts of Devon, and were banked up against the northern, eastern, and southern sides of Dartmoor. He assumes, moreover, that the post-Eocene elevation of the region gave this surface a general easterly slope; and consequently that, although streams ran off Dartmoor in all directions, those which drained eastward had the longer courses and passed from the moorland area on to a plain, the drainage of which was directed eastward to the shore of the Oligocene sea.

The general direction of the Upper Teign where it flows over the granitic area is east-north-easterly; the direction of its gorge as far as Clifford Bridge is nearly due east, and if the conditions were as above described, the precursor of this river is not likely to have followed the course of the present river beyond Clifford Bridge. There is not likely to have been any ridge or obstacle that would have deflected it so far to the southward, nor anything to prevent it from continuing its easterly course towards, and probably across, the valley of the Exe.

The valley of the Lower Teign below Dunsford is not likely to have existed in Oligocene time, but was part of the eastward sloping plain; the local drainage, however, may have been carried by a little brook flowing southward or south-eastward to join the river which was then initiating the valley of the Teign estuary. The erosion of the present longitudinal valley out of the Palæozoic rocks must have been accomplished in much later times, and was probably due to the development of the Permian escarpment.

The valley through which the Teign now flows from Newton to Teignmouth traverses this escarpment; and its excavation can only be attributed to a stream that flowed eastward from higher ground